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

A New Survey of Universal Knowledge

ENCYCLOPÆDIA BRITANNICA

Volume 1

A TO ANTARAH

ENCYCLOPEDIA BRITANNICA, INC.

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TO THE HEADS OF THE TWO ENGLISH-SPEAKING PEOPLES

JOHN FITZGERALD KENNEDY

PRESIDENT OF THE UNITED STATES OF AMERICA

AND

HER MAJESTY

QUEEN ELIZABETH THE SECOND

EDITORS' PREFACE

THE preface to the first edition of *Encyclopedia Britannica,* 1768, stated that utility is the "principal intention of every publication." The *Britannica*'s progressive history since that date has been one of expansion and enlargement, and the problem has been to hold the developing amount of information to a convenient and usable form. Times change, fresh information demands inclusion, and supplementary volumes added to old ones offer no adequate solution of the problem of keeping the reader abreast of the times; nor, indeed, do completely reset new editions solve the problem. Such editions in the past have taken many years to make, and material in one volume was old before the next volume was made.

The matured plan of continuous revision of the *Britannica* obviates these editorial difficulties.

By 1771 the *Encyclopedia Britannica* consisted of three volumes containing 3,000,000 words. Today the *Britannica* comprises twenty-four volumes with 38,000,000 words and the annually issued *Book of the Year.*

Experience through the years indicates that much of the material in an encyclopaedia needs changing only at fairly long intervals. Other material requires more frequent revision, some every year, some every two years, some every three years and so on. Under the *Britannica* plan of continuous revision, all the material in the set is scheduled in classifications for more extensive annual revisions than have ever before been possible in the history of encyclopaedias. The result is that, within the obvious limitations set by the structure and manufacture of an encyclopaedia of 38,000,000 words, the *Britannica* is never old. The second unit of the plan is the annual *Book of the Year,* which keeps the information of the *Britannica* owner current. It is itself an encyclopaedia of more than 1,000,000 words covering the significant events of each succeeding year.

The present *Encyclopædia Britannica* is a modern informational instrument in a changing and complex world. It is not the work of a few authors or of the authors of any one country. It is the result of the cordial co-operation of more than 9,000 authorities from most of the countries of the world. Without their help no good work of reference, covering information on every essential subject, could be made.

The reader can contribute much toward the economical use of the great quantity of material in this reference set by first turning to the Index volume when in search of information. The Index is the direct guide to the many thousands of topics in the more than 38,000 entries, and the way to use it is described on pages v–viii in the Index volume.

Turn to the next page in order to understand the rules for the alphabetization of articles in the set.

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HOW ENCYCLOPÆDIA BRITANNICA'S ARTICLES ARE ARRANGED— ALPHABETICALLY AND SYSTEMATICALLY

IN ORDER to make each of the 38,000 articles in the *Encyclopædia* Britannica easily accessible to the reader, the articles have all been placed in strictly alphabetical order throughout the set, regardless of the specialized fields to which they apply. An alphabetical listing on so large a scale requires clear and consistent methods for dealing with various details. The rules adopted by the editors of the Encyclopcedia *Britannica* were designed on the basis of long experience for maximum usefulness to the reader, and a few minutes spent in becoming acquainted with them will amply repay every user of the set.

First, it is important to note that titles *of* articles are in strict alphabetical order regardless *of* whether the title contains one, two or more words. Thus ARTILLERY precedes ART INSTITUTE OF CHICAGO. Separate words are alphabetized as if they were one word and this system continues up to the punctuation mark. Words in parentheses are not generally considered as part of the heading for purposes of alphabetization. Names beginning with Mc or M', St. or SS. are alphabetized as though they were spelled out; *i.e.*, Mac, Saint or Saints.

The position of articles which have the same name is determined by the order: (1) persons; (2) places; and (3) things. When there are a number of biographical entries for persons bearing the same name, they are arranged in the order: saints, popes, emperors, kings, nobility in order of preference, persons other than the above bearing the one name only, and persons bearing the name as a surname. Thus JOHN, SAINT, THE APOSTLE, precedes JOHN I, Byzantine emperor; JOHN, duke of Burgundy, precedes JOHN OF ASIA, who in turn precedes JOHN, AUGUSTUS EDWIN.

Popes of the same name are included in one article. Within the article, the popes are listed in order by number. Kings of the same name are alphabetized by the name of their realms, and numbered kings of the same name and realm are arranged by number. Thus JOHN II, king of Aragon, precedes JOHN I, king of Castile. Others whose names include numbers, such as emperors, are also arranged by number.

Territorial designations and sobriquets (ROBERT OF GLOUCESTER; HOLBEIN, HANS, THE YOUNGER) are not considered in alphabetizing unless there are two or more entries with titles which are otherwise the same. These entries are then alphabetized by the first principal word of the subsidiary designation, the "of" or "the" being disregarded. Thus JOHN, SAINT, THE APOSTLE, precedes JOHN, SAINT, OF THE CROSS; JOHN OF ASIA precedes JOHN OF SALISBURY.

Persons with the same family name are arranged in relation to each other by alphabetizing the given name. Persons with the same family and given name are arranged by date of birth, the earliest coming first. Titles such as "Sir" or "Dame" are not considered in alphabetizing. Unused portions of given names, when they precede the name that is .used, are enclosed in parentheses and are also disregarded in alphabetizing. CHAMBERLAIN, SIR (JOSEPH) AUSTEN thus precedes CHAMBERLAIN, (ARTHUR) NEVILLE.

Names with connectives such as "de," "von," etc., are generally alphabetized under the main part of the name—GOGH, VINCENT WILLEM VAN—except where the European form has been anglicized, as in DE QUINCEY and DU PONT.

Places of the same name are arranged in the order: (1) countries; (2) subordinate divisions, such as *département*, province or state; (3) cities; and (4) geographic features, such as islands, mountains, lakes and rivers. Cities of the same name are alphabetized, in relation to each other, by the names of their countries: ALBANY in Australia precedes ALBANY in New York, U.S. Cities of the same name and country are arranged by alphabetizing the territorial unit next below the country: ALBANY, Georgia, U.S., precedes ALBANY, New York, U.S.

In addition to the main articles, there are thousands of cross references throughout the Britannica. These appear as boldface entries in alphabetical position in the text (*e.g.*, DISRAELI, BENJAMIN: see BEACONSFIELD, BENJAMIN DISRAELI, EARL OF); the "see" and "*see* also" references to other titles in the body or at the end of articles; and the parenthetical *q.v.* (quod vide "which see") references, which indicate that separate articles under the titles cited will be found in the *Britannica*.

It is important to read also the introductory sections *of* the *Index* volume, which explain how the articles are indexed alphabetically by subject matter.

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BASIL WILLEY, *King Edward VII Professor of English Literature, Cambridge University, Cambridge, England.* (LITERATURE)

OSCAR OSBCRN WINTHER, *Professor of History, Indiana University, Bloomington, Indiana* (GEOGRAPHY: NORTHWEST CENTRAL U.S.)

ROBERT WOERNER, *Business Manager, Midwest Program on Airborne Television Instruction.* (ELECTRICAL ENGINEERING)

ROBERT SMITH WOODBURY, *Associate Professor of History of Technology, Massachusetts Institute of Technology, Cambridge, Massachusetts.* (TECHNOLOGY)

QUINCY WRIGHT, *Emeritus Professor of International Law, The University of Chicago, Chicago, Illinois.* (INTERNATIONAL RELATIONS)

DOROTHEA WYATT, *Counselor to Women and Associate Professor of History, Flint College, University of Michigan, Flint, Michigan.* (GEOGRAPHY: EAST NORTH CENTRAL U.S.)

THOMAS FRASER YOUNG, *Professor of Chemistry, The University of Chicago, Chicago, Illinois.* (CHEMISTRY)

A full list, in alphabetical order by initials, of all the writers for the *Encyclopædia Britannica* is to be found at the back of the Index volume. Following it is an alphabetical list by name.

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ENCYCLOPÆDIA BRITANNICA

Volume 1

A TO ANTARAH

A THIS letter has stood at the head of the alphabet (*q.v.*) during the whole of the period through which it can be traced historically. The name of the letter in the Phoenician period resembled the Hebrew name *aleph* meaning "ox"; the form is thought to derive from an early symbol resembling the head of an ox. The letter was taken over by the Greeks in the form of *alpha.* In the Phoenician alphabet the letter stood for a species of breathing, since vowels were not represented in the Semitic alphabets.

Throughout its history variations have occurred in the form of the letter. The Phoenician form was  . In the Lydian alphabet of the 5th century B.C. it appeared as  , in the Carian alphabet  or  . In the early Greek alphabet from the island of Thera, which may possibly be dated as far back as the 8th century B.C., its form was  or  . In the Greek alphabet of classical times its form was usually  . Early Italic and Latin forms were  and  . As early as the middle of the 2nd century A.D.  is found as a form of  , and this is the ancestor of the present minuscule printed a by way of uncial  (4th century) and  (8th century), uncial writing being the name given to the round hand which in late Roman times superseded the square capitals that had been suitable for inscription in stone. Under the influence of the uncial hand this form was adopted into Carolingian minuscules. The rounded minuscule *a* derives from Latin cursive, in which in the 5th century A.D. appeared the astonishing form  This was a hastily written majuscule  distorted by its apex having fallen to the left. In the 6th century the cursive form was  , and from this in the 7th century developed the form  from which the rounded form of the Irish and early English hands grew. The rounded capital  that sometimes appeared in handwriting was the minuscule letter written large.

The sound for which the letter consistently stood in Greek and Latin was the open low back vowel, sometimes known in modern English as continental *a.* There are of course countless slight variations in the method of pronouncing this sound. In English the sound has undergone far-reaching changes during and since the Middle English period. These are due to *fronting,* that is to say, pronouncing the sound more toward the front of the mouth, or to *rounding,* slightly rounding the lips, which has the effect of causing the sound to be pronounced higher in the mouth. At the present time the letter represents six principal vowel sounds: (1) its original value, the low back vowel, as in *father;* (2) an intermediate vowel, as in *man;* (3) a closer vowel, further fronted, as in *hare,* occurring only before the liquid *r;* (4) a dipthong *(ei)* as in *take, spade.* This is the sound that the letter now normally represents when the vowel is long.

(3) Represents a stage in the development of the sound on its way from (1) to (4) which was arrested at this point when the

word was followed by r. A similar fronting of this sound took place in the Ionic-Attic dialects of Greek, where sounds derived from the a-sound and represented in other dialects by *a* are represented by *η*.

The two remaining developments of the sound are due to rounding: (5) the vowel of water and (6) the vowel of was. This development is due to the influence of the preceding bilabial spirant *w*. (B.F.C.A.; J.W.P.)

In music, A is the name of the first note of the musical alphabet and constitutes the 6th degree of the scale of C. In respect of pitch A is equal to 440 vibrations per second, this being the standard pitch.

A is the note always given to orchestral players, usually by the oboe, for tuning purposes.

See PITCH, MUSICAL.

AA, the name of many small European rivers. The word is derived from the Old High German aha, cognate to the Latin *aqua,* "water" (cf. Ger. *-ach;* Scand. *å, aa,* pronounced *ō*). Among the streams of this name are: two rivers in western U.S.S.R., entering the Gulf of Riga with Riga lying between their mouths; a river in northern France flowing through St. Omer and Gravelines; and a river of Switzerland, in the cantons of Lucerne and Xargau, which carries the waters of the "finger" lakes of Baldegger and Hallwiler into the Aar (Aare). In Germany there are the Westphalian Aa, joining the Werre at Herford, the Munster Aa, a tributary of the Ems, and others. (A. F. A. M.)

AABENRAA-SONDERBORG (officially ÅBENRÅ-SØNDERBORG) is a county district of Denmark comprising the separate county council districts (amtsraadskredse) of Aabenraa and Sonderborg.

Aabenraa has an area of 305 sq.mi. and a population (1955) of 48.676 and its boundaries extend in an arc from Genner fiord to Flensborg fiord. It is centred on the town of Aabenraa (pop. [1955] 13,793), a port at the head of Aabenraa fiord (an arm of the Little Belt) which has a good harbour and a large import trade. Graasten (pop. [1955] 2,629) is another centre.

The county of Sonderborg embraces the island of Als and the adjacent Sundevedpeninsula of southeast Jutland; area 170 sq.mi.; pop. (1955) 49,604. Hummocky moraine prevails in the east: and the fertile clay loams support wheat, barley, oats, roots, dairy cattle and pigs. In the west, poorer soils cover the outwash sands and gravels. The principal town is Sonderborg (pop. [1955] 18,418), a port and seaside resort on the southwest coast of Als Island, connected with the mainland by a double-bascule bridge (built 1925–30). Sonderborg castle. dating from medieval times. houses a museum. Textiles, machinery, margarine and beer are manufactured. The town has existed since the mid-13th century and was burned down in 1864 during the assault by the Prussians on the Diippler trenches. With the whole district it then passed to Germany. but was restored to Denmark by the plebiscite of 1920. Dybbol Mill, the scene of the heroic Danish resistance in 1864, is now a symbol of national unity. (HA. T.)

AACHEN (Fr. AIX-LA-CHAPELLE; Dutch AKEN), an ancient city and spa of Germany, Land of North Rhine-Westphalia, Federal Republic of Germany, is situated under the northern slopes of the Ardennes, 70 km. (43.5 mi.) S.W. of Cologne by road. Pop. (1950) 129,811. Its municipal boundaries coincide on the west with the frontiers of Belgium and the Netherlands. The hot sulfur springs have been celebrated for centuries. In appearance it is a prosperous, modern commercial town but it is full of medieval associations. The outer town is mainly new. while the ramparts of the old inner town are now promenades, with two ancient gates. Ponttor and Marschiertor, remaining. The conspicuous cluster of buildings in the centre of the city includes the cathedral and the Rathaus (town hall), a Gothic structure (1353–70) built on the ruins of Charlemagne's palace, which contains the magnificent coronation hall of the emperors (143 ft. by 61 ft.) where 32 Holy Roman emperors and kings have been crowned. The two original towers, Granusturm and Glockenturm, were all but destroyed by fire in 1883; their restoration was completed in 1902. Near the Rathaus is the Grashaus, restored in 1889 to contain the municipal archives. The cathedral has two distinct styles: the Octagon is Carolingian Romanesque and the choir is Gothic. The Octagon, begun about 796, was modeled on San T'itale at Ravenna and consecrated by Pope Leo III in 805. It is the finest extant building in that style. It suffered damage at the hands of the Normans in 881 and was later restored on the original lines It is surrounded on the first story by a gallery (the Hochmunsterj with antique marble and granite columns. of various sizes, brought from Rome, Ravenna and Trier. The columns were removed by Napoleon to Paris, but mere in part returned after 1815. The mosaic representing Christ surrounded by "the four-and-twenty elders," which originally lined the cupola, was executed in 1881 from a 17th-century copy of the ancient originals. The bronze west doors date from 804. Underneath the dome, tradition places the tomb of Charlemagne, said to have been opened by Otto III in 1000 and to have shown the emperor's body on a marble chair which was removed and long used for coronations. It is now in the gallery. The site of the tomb is marked by a stone slab, with the inscription *Carlo Magno,* and above it hangs the famous bronze chandelier presented by the emperor Frederick I (Barbarossa) in 1168. In the Hungarian chapel. to the southwest, is the rich cathedral treasury, with fine medieval work such as the 13th-century gold casket containing the relics of Charlemagne. The Gothic choir was added during the 14th and 15th centuries and contains the tomb of the emperor Otto III. The pulpit. a gift of emperor Henry II, dates from *c* 1020. The cathedral possesses many relics, the more sacred of which are exhibited only once every seven years, when they attract large crowds.

The churches of St. Foillan (founded in the 12th century, but twice rebuilt, in the 15th and 17th centuries, and restored 1883–88) and St. Paul. with its beautiful stained-glass windows, are interesting The Suermondt museum contains good pictures by early German. Dutch and Flemish masters. There are many fine streets, squares and public monuments. The fountain in the market square is surmounted by a statue of Charlemagne. In the principal square, Friedrich-Wilhelmplatz, is the Elisenbrunnen, with its colonnade and garden, the chief resort of visitors taking the baths and waters. Educational institutions include the Rheinisch-M'estphalische Technische Hochschule, a polytechnic founded in 1870.

Aachen is on the main line from Cologne to Brussels. Since the working of extensive coal fields in the district almost every branch of iron industry has been carried on. Cloth, glass, needles and pins are important products. The suburb of Burtscheid, incorporated with Xachen in 1897, has old established manufactures of cloth and needles and contains, among frequented thermal springs, the Schwertbad-Quelle (171° F.). the warmest spring in Germany.

History. — The ancient city and watering place of Aachen represents the Aquisgranum of the Romans, named after Apollo Granus, who was worshiped in connection with hot springs. As early as A.D. 765 King Pepin III had a palace there, in which it is probable that Charlemagne was born. The greatness of Aachen was attributable to the latter, who between 777 and 786 built a magnificent palace, raised the place to the rank of the second city of the empire, and made it for a while the centre of western culture and learning. From the coronation of Louis the Pious in 813 until that of Ferdinand I in 1531 the sacring of the German kings took place at Aachen. Late in the 12th century (1172–76) the city was surrounded with walls by order of the emperor Frederick I, to whom (in 1166) and to whose grandson Frederick II (in 1215) it owed its first important civic rights. In the 16th century Aachen began to decline. It lay too near the French frontier to be safe, and too remote from the centre of Germany to be convenient as a capital; and in 1562 the election and coronation of Maximilian II took place at Frankfurt am Main, a precedent followed till the extinction of the empire. Aachen was the scene of several important peace conferences, notably the treaty of 1668 that ended the War of Devolution, and the peace of 1748 ending the War of Austrian Succession. The city was occupied by French troops in 1794 and was annexed in 1801 by France, who held it until the congress of Vienna (1814–15), after which it was given to Prussia. The Aachen congress, sealed in 1818, regulated the affairs of Europe after the Napoleonic wars. In Nov. 1918, at the conclusion of World War I, Aachen was occupied for a period by Belgian

troops. During World War II it mas bombed many times and was captured on Oct. 20, 1944, the first large city on German soil to fall to the Allies.

AANMES: see AHMOSE.

AAL (A'L, ACH or AICH), the Hindustani names for the *Morinda tinctoria* and M. *citrifolia,* plants extensively cultivated in India because of the reddish dyestuff which their roots contain. The name is also applied to the dye, but the common trade name is *suranji.* Its properties are a result of the presence of a glucoside known as morindin.

AALBORG (officially ALBORG), a seaport in northern Jutland, Den.. and capital of the *amt* (county) of Aalborg, lies on the south side of Limfjord, with its suburbs of Hasseris, Norresundby and Sundby-Hvorup extending on both sides of the fiord. Pop. (1955) 83.210; greater Aalborg 91.997. Area 52 sq km. (20 sq.mi.). Founded in 1342, and one of the oldest towns in Denmark. Aalborg has many buildings of interest including the Holy Ghost monastery (1431), the cathedral of St. Botolph, Aalborghus castle (1539) and several old merchant houses. There is a modern town hall and a theatre, as well as several schools and colleges, and six parks. fine zoological gardens and a racecourse. In the museum and art gallery some of the relics from the Viking village of Lindholm Hoje are preserved. Aalborg has an international airport with flights direct to Norway and Copenhagen. The port has considerable overseas trade and the town manufactures cement, tobacco, chemicals and spirits. It is also an important shipbuilding centre.

The county of Aalborg, bounded in the south by the Mariager fiord and in the north by the Geraa river, has an area of 1,125 sq.mi. Pop. (1955) 232,855. It has poor quality soil and there are two large areas of moorland. (P. E. JE.)

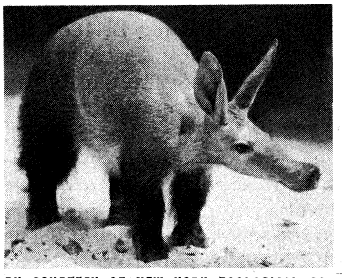
AALSMEER, a village in the province of North Holland, Neth , lies about 10 mi. S.W. of Amsterdam. Pop. (1957 est.) 13.861 (mun.). It is an important flower-growing centre with nearly 1.000 nurseries. The older part is on peaty soil at about sea level surrounded by polders with loamy soil, 9–15 ft. below sea level The principal products are carnations (approximately 119.000 000 a year), cut roses (88,000,000), lilacs (9,000,000), freesias (45,000,000), chrysanthemums and potted plants such as cyclamens and begonias. About half the flowers are exported and there is a big trade in seeds and nursery plants. There are two flower auctions and an experimental station for floriculture. The Resteinder lake is popular for sailing. (JA. W.)

AALST (Fr. ALOST), an industrial town of Belgium in the province of East Flanders, lies on the Dender river where the undulating countryside of mid-Belgium levels out to the coastal plain. 26 km. (16 mi.) by road west-northwest of Brussels. Pop. (1955 est.) 43.537. The town hall. begun between 1200 and 1225, is the oldest in Belgium and contains a 43-bell carillon. The town archives include 12th-century manuscripts. The large, but unfinished, church of St. Martin has a transept containing remarkable furnishings, sculptures and a Rubens painting. Aalst is on the railway from Brussels to Ghent. and the E5 motorway from Brussels to Ostend skirts the town. The manufacture of textiles, from the linen thread to the finished cloth. and the making of clothing and textile machinery are the chief industries. Hops provide malt for flourishing breweries. The first printing shop in the Low Countries was established at Aalst by Thierry Martens (later a professor at the University of Louvain) in 1473. Marshal Turenne took the town after a four-day siege in 1667 during the War of Devolution that gave southern Flanders to France. During World War I the town was in German hands from Sept. 1914 until Nov. 1918. In World War II the Germans occupied Aalst from May 1940 until Sept. 1944. (R. M AN.)

AALTO, ALVAR (1898–), Finnish architect, designer and planner, whose works have influenced modern design throughout the world. especially for their sensitive treatment of natural materials. was born in Kuortane, on Feb. 3, 1898, and studied at the Helsinki Institute of Technology. His sanatorium at Paimio (1923–33), the library at Viipuri (1927–33, destroyed) and other buildings helped introduce modern architecture into Finland and Scandinavia. Featuring native materials, brick and timber, as well as concrete, his works range from private dwellings, like the Gullichsen house (1938–39), to the Sunila Cellulose Products factory (1937–39) and community buildings at Sanynatsala (1951–32). He built the Finnish pavilion at the New York World's fair (1939) and the Massachusetts Institute of Technology senior dormitory (1947–49). Aalto also designed influential standardized plywood furniture. He was ably assisted by his architect-wife Aino (1894–1949).

See Sigfried Giedion, Space, Time and Architecture, 3rd ed. (1954); Eduard and Claudia Neuenschwander, Finnish Architecture and Alvar *Aalto* (1954). (A. K. P.)

AARDVARK, "earth-pig," the Dutch name for an exclusively African termite-eating mammal of the genus Orycteropus, comprising the order Tubulidentata (*q.v.*). It is a curious looking animal, of unknown relationships, having a stout piglike body, long snout, donkeylike ears and powerful short, thick legs armed with strong, blunt claws. The body averages four feet in length, with the tail an additional two feet. In colour the Cape aardvark is pale sandy to yellow, the hair being scanty and allowing the skin to show; the northern form has a still thinner coat, a shorter tail and longer head and ears; the western has the fullest coat, a glossy black fur.



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AARDVARK (ORYCTEROPUS AFER), NATIVE OF AFRICA

The arrdvark lives in both forest and plains country, wherever their insect food is plentiful. This highly specialized digger excavates large burrows in which it rests by day, venturing out at night to forage. After digging into and demolishing a large termite hill. the aardvark rapidly laps up the routed insects with its sticky, foot-long tongue.

Aardvarks are not aggressive, but when attacked, usually by larger carnivores such as lions and leopards, they roll over and use their powerful claws to good effect. A single young is born in summer. Besides keeping termites in check, the aardvark is also important in the native economy for its edible flesh and its teeth, prized as amulets to ward off evil.

AARDWOLF (Proteles *cristatus*), a mammal superficially resembling a small striped hyena and about 30 in. long, of which the tail accounts for 8 in. It has front legs longer than the hind, large ears and a pointed muzzle. The colour is buffish-gray with dark vertical stripes, dark muzzle and forefeet. A long, coarse-haired erectile mane runs the length of the back. Aardwolves live in the drier parts, but not the forests, of eastern and southern Africa and are usually nocturnal. They inhabit burrows, feed largely on termites, are usually solitary but sometimes forage in small packs The litter averages three. They are mild. harmless animals whose only defense is to emit a musky smelling fluid and run away. See also CARNIVORE. (L. H. M.)

AARE or AAR, the longest river entirely within Switzerland, is 295.2 km. (183 mi.) long and the area of its basin is 17,779 sq km. (6.864 sq.mi). It rises in the Aare glacier in the canton of Bern. below the Finsteraarhorn and west of the Grimsel pass. Near there an artificial lake, 7 mi, long, was created behind two dams nhich control the flow of nater to the Grimsel underground power station. Below the Handegg falls, the Aare drains the Oberhaslital and there a power station was built in the Aare gorge at Innertkirchen above Meiringen. The Aare expands into the glacial lake of Brienz, on the southern shore of which the spectacular Giessbach falls occur. The river then crosses the lake delta of the Bodeli at Interlaken as a canalized river, before expanding into the similarly formed lake of Thun, at the lower end of which is the medieval castle town of Thun. Flowing northwest in a deeply entrenched valley, the Aare almost encircles the peninsula on which the medieval core of the city of Bern (*q.v.*) lies, then turns west and finally north to Aarberg, where it is diverted west by the Hagneck canal into the lake of Biel (Bienne). It subsequently flows northeastward parallel to the foot of the Jura, past

the castle towns of Solothurn, Olten and Aarau. The chief right bank tributaries in this section are the Grosse Emme, Wigger, Suhr and Aa. Below Brugg, first the Reuss and then the Limmat converge on the Aare. The combined rivers turn north to join the Rhine at Coblenz. (A. F. A. M.)

AARGAU (Fr. ARGOVIE), a canton of northern Switzerland, takes in the lower course of the Aare river (*q.v.*), whence its name. The capital is Aarau and the total area of the canton is 1,403.5 sq.km. (542 sq.mi.). It forms the northeastern section of the great Swiss plateau between the Alps and the Jura. Its fertile valleys alternate with pleasantly wooded hills.

In 1415 the Aargau region, previously the centre of the Habsburgs, was taken from them by the Swiss Confederates. Bern kept the southwestern portion. In 1798 the Bernese part became the canton of Aargau of the Helvetic republic and the remainder of the Aargau region formed the canton of Baden. In 1803 the two halves (plus the Frick glen, ceded in 1802 by Austria to the Helvetic republic) were united under the name of Canton Aargau and admitted to membership of the Swiss confederation.

The population in 1950 was 300,782 and in 1957 was 340,753, almost exclusively German-speaking with Protestants predominating. The canton is governed by an executive council of five members who are elected by direct vote, and it sends 13 members (on the basis of the 1957 census) to the federal *Nationalrat.* The principal industries are agriculture, dairying and fruit growing, straw-plaiting, electrical engineering, the making of precision instruments, cement and cigars, and the mining and refining of salt. The canton has much to offer the tourist in its beautiful landscape, its ancient castles and its museums with their artistic treasures. Baden (*q.v.*), an important city in the canton, has a tourist industry based on hot sulfur springs.

AARAU, capital of the canton, had a population (1950) of 14,280. At the southern foot of the Jura, it is built in terraces on the right bank of the Aare and is 50 mi. by rail N.E. of Bern and 31 mi. W, of Zürich. In the newer parts industries have grown up, the most important of which produce footwear and precision instruments.

Once an ancient fortress, it was taken by the Bernese in 1415, and in 1798 became for a time the capital of the Helvetic republic. The cantonal library has a fine collection of books and manuscripts, and the art gallery an important collection of pictures. Eight miles by rail northeast of Aarau is Schinznach Bad whose famous sulfur waters have been used for medicinal purposes since the end of the 17th century. Near Schinznach Bad is the ruined castle of Habsburg, or Habichtsburg (hawk's castle), the original home of the Habsburg family.

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AARHUS (officially ÅRHUS), a seaport, the capital of Aarhus *amt* (county), and the second town in Denmark, lies on the east coast of Jutland on Aarhus bay. Area 20.5 sq.km. (7.9 sq.mi.) (including suburbs, 114.2 sq.km. [44.1 sq.mi.]). Pop. (1955) 118,943 (including suburbs, 165,522).

The oldest buildings in the town are the 11th-century crypt of St. Nicholas under the Church of Our Lady and the 13th-century cathedral. The town hall built in 1941 by A. Jacobsen and E. Möller and the university (1932) by C. F. Moller are fine examples of modern Danish architecture. There is an art gallery, a prehistoric museum and Den Gamle By, a unique open-air museum of an early Danish town. Aarhus has a botanical garden and several other parks. In addition to the university (opened 1928) there are training establishments for dentists, journalists and technicians; a merchant high school; and four teachers' training colleges.

Aarhus is the centre of both transport and commerce in Jutland. The harbour, with a maximum depth of 33 ft., has eight docks. Daily services are maintained from Aarhus to Kalundborg; Copenhagen; Halmstad, Swed.; and Oslo, Nor. From the Tirstrup airfield, 37 km. (23 mi.) N.E., there are daily flights to Copenhagen. The major industries of Aarhus are metals and chemicals.

Though the origin of the town is unknown, it became an episcopal residence as early as 948. The oldest existing charter dates from 1441 and refers to a still earlier one. Since the beginning of the 19th century Aarhus has expanded rapidly.

Aarhus county (area 311 sq.mi., pop. [1955] 210,409) is low-lying, fertile farming country with a large amount of woodland. (J. JE.)

AARON, the traditional founder and head of the Jewish priesthood, who, in company with Moses, led the Israelites out of Egypt (see EXODUS; MOSES). He is described as a son of Amram and Jochebed of the tribe of Levi, and as three years older than his brother Moses (Ex. vi, 20; vii, 7). He acted together with his brother in the desperate situation of the Israelites in Egypt (Ex. iv ff.), and took an active part in the exodus. While Moses was the actual leader, Aaron acted as his "mouth" (Ex. iv, 16). The two brothers went to Pharaoh together, and Aaron told the king to let the people of Israel go (Ex. vii). He used his magic rod in order to show the might of Yahweh. When Pharaoh finally decided to let the people go, Yahweh gave the important ordinance of the Passover to Aaron and Moses (Ex. xii, 43 ff.). But Moses alone went up on to Mt. Sinai, and he only was allowed to come near to Yahweh (Ex. xxiv, 2). Moses later was ordered to "bring near" Aaron and his sons with him, to serve as priests (Ex. xxviii, 1). They should be brought to the tent of meeting, washed with water and have the priestly garments put on them. Aaron received a coat and the robe of the ephod, the breastpiece, the turban and the holy crown upon the turban. He and his sons were anointed and consecrated to be priests "by a perpetual statute" (Ex. xxix). Aaron's sons were to take over the holy garments after him.

Aaron is not represented as aholly blameless. When Moses was delayed on Mt. Sinai, the people gathered and asked Aaron to make them gods. Aaron told them to bring their gold rings, and with them he made a golden calf, upon which the people declared: "These are your gods, O Israel, who brought you up out of the land of Egypt." Aaron was then reproached by Moses, and the people were punished (Ex. xxxii).

Only once a year. on the Day of Atonement, Aaron was allowed to come into the Holy Place within the veil, bringing his offering (Lev. xvi). He mas solemnly installed as the leader of the Levites, who were consecrated to minister at the temple. Aaron and his sons were given monopoly as priests (Num. iii). Together with his sister Miriam, Aaron spoke against Moses because he had married a foreigner (a Cushite woman), but as in the episode of the golden calf the narrative in Num. xii tells how Aaron was merely reproved, though Miriam was punished, for the offense. In the rebellion of Korah the Levite, however. Aaron stood firmly at the side of Moses (Num. xvi). Aaron died on the top of Mt. Hor at the age of 123 (Num. xxxiii, 39). In Deut. x, 6, which represents another tradition, Aaron is said to have died in Moserah and was buried there, while Deut. xxxii, 50 has the same tradition as Num. xx.

Aaron is a central figure in the traditions about the exodus, though his role varies in importance. At the beginning he seems to be co-equal with Moses (cj. also Mic. vi, 4), but after the march out of Egypt he is only a shadow at the side of Moses. Moses is obviously the leading person in the tradition, but it is also clear that he is pictured as delegating his authority in all priestly and cult matters to Aaron and "his sons."

Aaron and the Biblical Critics.—Scholars have long been aware that the figure of Aaron as it is now found in the Pentateuch (*q.v.*) is built up from several sources or layers of traditions. According to J. Wellhausen and his followers the Yahwistic source was the oldest one, with the Elohistic one following next, then later the Deuteronomist and finally the Priestly Codex. Scholars have distributed the passages about Aaron to one or the other of these sources. Although their results differ, they do agree in ascribing about 90% of the material about Aaron to the Priestly source, which was written after the exile, and which is also the source that can be most easily traced. According to Wellhausen, Aaron was not mentioned at all in the early (Yahwistic) narrative, but he may have been inserted by later redactors. It was Moses who was the hero of the priests before the exile (Ex. iv, 17; xxiv),

and it was Joshua, not Aaron, who officiated in the tabernacle (Ex. xxxiii, 7–11).

Other scholars, such as S. Mowinckel, are of the opinion that the narrative about the golden calf, which presents Aaron in an unfavourable light, was part of the ancient traditions in the Yahwistic work, being the only passage in the latter where Aaron was mentioned. This narrative, according to these scholars, originally came from the northern kingdom of Israel and described Aaron as the ancestor of the priests in northern Israel, but it was later rewritten in a way defamatory to Aaron. But there are also features in the narrative which may indicate that a later source (or traditionist), the Elohist, tried to excuse Aaron and to put the main responsibility on the people. The Elohistic narrator was credited with making Aaron the brother and helper of Moses (Ex. iv, 14–17, 27–30), who stood at the side of Moses under the conflict with Pharaoh (Ex. v, vii–x) and assisted Moses as a leader in battles (Ex. xvii, 7–13) and in the cult (Ex. xviii, 12). It may also be the Elohist who provides the unfavourable story about Aaron's objection to Moses' wife (Num. xii). On the other hand it seems to be the same narrator who mentions Aaron at the side of Moses in the revolt at Meribah (Num. xx), but here also Aaron, together with Moses, is actually reproached. There is reason to believe that Aaron was not mentioned in the Deuteronomistic work by the original author, but that his name has been added by a redactor. for instance in Deut. ix, 20, x, 6 and xxxii, 50. The main bulk of the traditions about Aaron, and the frequent addition of "and Aaron" after the mention of Moses, are found in the Priestly source, which was written at a time when the priests had a more dominating position in Judah than they had before the exile. By then Moses had ceased to be the hero of the priests, and Aaron had taken over that role.

Many modern scholars prefer to speak of traditions and layers of traditions where their predecessors spoke of sources, but apart from this terminology the view concerning Aaron has not greatly changed. There have been new attempts, however, to see the contrasting figures of Moses and Aaron in new light. It has been suggested that the traditions about Moses represent a southern, Judean tradition, while the old traditions about Moses originated in the northern kingdom. It has also been indicated that the traditions about Moses are primarily concerned with a prophet, while those about Aaron are connected with priesthood. There may be a kernel of truth in all these suggestions, as also in the theory of I. Engnell that Moses represents the royal ideology while Aaron stands for priesthood, and priesthood alone. The standing struggle between the king and the leading priests is reflected both in the laws and in the narratives of the historical books. The descriptions of the relationship between Aaron and Moses—priest and king—are coloured by this struggle, for instance in Lev. xvi, Ezek. xlv, II Chron. xxvi, 16 ff. In the long run the priests were victorious, but Moses at the same time won an authority that could not be shaken.

Aaron in Later Jewish Thought.— Aaron continued to live as a symbol in Jewish religion and traditions. The position of the priests was strengthened after the exile, a fact which can be seen in Ezek. xl ff.. Chronicles and Ezra. Also in the Qumran sect Aaron was a symbol for a strong priesthood, as can be seen from the Dead sea scrolls. At the end of time men of the community should be set apart, as a house of holiness for Aaron. Only the sons of Aaron should "administer judgement and wealth," and according to the *Manual* of Discipline two Messiahs were expected, one of Aaron, the priestly one, and one of Israel. According to a fragment found near Qumran the priest would have the first seat in the banquets in the last days and bless the bread before the Messiah of Israel. Here "the sons of Aaron" have the highest position.

In Midrash and Talmud Aaron is seen not so much as a symbol as the leading personality at the side of Moses. The relationship between the two brothers is painted as prototypical in the Hag gadah. Rabbi Hillel praised Aaron as peace-loving, a man of good will, who wanted to teach his fellow men the Law (*see* Talmud: Aboth 1. 13). In the Haggadah his rod also played a role (cf. Num. xvii, 16–26). In Jewish exegesis little is said about him, though he is mentioned as a man who created peace among men. Many attempts have been made to explain the episode of the golden calf. According to some exegetes Aaron had to make the calf in order to avoid being killed. Gersonides (1288–1344) explained that this would have been fatal, not only for Aaron, but even more for the people. Ibn Ezra (c. 1090–1164) underlined that here was no apostasy, and Rashi (1040–1105) contended that the calf was a symbol for the leader, Moses, who was at that time on the mountain. The relationship between Moses and Aaron also is discussed in the Talmud. Some traditionists have wondered why Aaron and not Moses was appointed high priest. The answer has been found in an indication that Moses was rejected because of his original unwillingness when he was called by Yahweh (see Talmud: *Zebahim* 102 a). It also seems to have been hard for some traditionists to accept that Aaron was described as older than his brother Moses (see Talmud: Sota 12 b). The death of Aaron is described in the Midrash Petirat *Aharon.*

Aaron in Christian Symbolism.— The first Christian communities admitted that Aaron, "the sons of Aaron" or "the order of Aaron" were symbols of the highest priesthood. But from the Epistle to the Hebrews (iv ff.), where Christ is described as a High Priest according to the order of Melchizedek, which was set over against "the order of Aaron" (Heb. vii), it can be seen that this caused problems. Of the church fathers, Cyril of Alexandria in his De adoratione i, 11 says that Aaron was divinely called to a priesthood in spirit and in truth, and that he was a type of Christ. Cyril also goes into the symbolism of Aaron's garments and their ornaments. Gregory the Great in his 33rd homily translates the name Aaron as "mountain of strength," and sees in him a redeemer, who mediated between God and man. Isidore of Seville in his 60th scriptural allegory takes Aaron as a sacrificer. representing Christ who effaced the sin of the world through his blood. Alcuin in his commentary on Ps. cxxxiii saw in Aaron the type of Christ, who penetrated into the Holy of Holies, not with the blood of others but with his own blood, to intercede for the world with the Father.

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AARON'S-ROD, the popular name given to various tall flowering plants, such as garden orpine (Sedum *telephium*) or live-forever, great mullein (Verbascum thapsus) and goldenrod (Solidago).

AASEN, IVAR ANDREAS (1813–1896), Norwegian philologist. who constructed one of the two official languages of Norway. was horn at Aasen i Orsten, in Sondmore, Aug. 5, 1813. His first publication was a small collection of folk songs in the Sondmore dialect (1843). The Grammar of the Norwegian Dialects (1848) and the Dictionary of the Norwegian Dialects (1850) prepared the way for the wide cultivation of the popular language in Norwegian. With certain modifications, the language Aasen constructed, which is now called nynorsk, rapidly assumed an importance comparable to that of Dano-Norwegian. Aasen composed poems and plays in the composite dialect and continued to enlarge and improve his grammars and his dictionary. Quite early in his career (1842) he had begun to receive a stipend to enable him to give his entire attention to his philological investigations. Aasen died in Christiania (now Oslo), Sept. 23, 1896.

ABA, a town of Eastern region of Nigeria. Africa, lies on the west bank of the Aba river. about 40 mi. N. of Port Harcourt, in the heart of the tropical rain forest but high enough above sea level to be clear of mangrove and fresh-water swamps. Pop. (1952–53) 57,787, (1959 est.) 62,500. Area about 13 sq.km. (5 sq.mi.).

The town came into existence with the gradual pacification of the village communities of the area in the early years of the 20th century. Its development was hastened by the arrival in 1915 of the railway from Port Harcourt, extended to Enugu in 1916, and the subsequent construction of roads. By 1933 Aba was a settled urban area and a principal centre of trade. The town was laid

out on modern lines around the main street, Asa road. There is a government school, a technical engineering school, Roman Catholic and Qua Iboe missions, a golf course and a prison.

Aba is the centre of a palm oil and palm kernel producing district and contains large and well-equipped soap factories. Other industries established or projected include furniture, textiles, concrete, aluminum ware and a brewery. The town is linked by road as well as by rail to Port Harcourt and Enugu (150 mi). capital of Eastern region, and by road to the federal capital, Lagos (510 mi.). It is within reach of the airport at Port Harcourt.

(W. H. I.)

ABACÁ FIBRE (MANILA HEMP), one of the most valuable of all fibres for cordage, is the product of *Musa texfilis,* a plant of the banana family (Musaceae). This fibre is also known in the trade as manila and manila hemp, but abaci is a hard fibre and is entirelv different from true hemp, which is a soft fibre and is the product of *Cannabis sativa.*

SHELL

STRIPPING, OR "TUXYING," STALK OF ABACÁ (MUSA TEXTILIS). STRIPS ARE CLEANED AND DRIED. AFTER WHICH THEY ARE GRADED AND BALED FOR USE IN MAKING CORDAGE

The abacá plant, which resembles in appearance tl banana and plantain, t which it is closely related, is a perennial. Numerous suckers grow from the rootstocks, forming a cluster of stalks 10 to 25 it. in height. These stalks, formed by the ', overlapping leaf stems, bear at the top a crown of large, undivided leaves. The ɔ of growth is t the base. The flower stalk is pushed up through the centre of the plant, bearing at the top flowers that are followed by fruits similar to small bananas but filled with black seeds. Abaci plants grown from seeds do not come true to type, so the plant is propagated from suckers or from rootstocks.

The abaci plant flowers when about two years old, at which stage it is in the most favourable condition for the production of fibre. The stalk is cut down, and the outer fibre-bearing layer of each successive leaf stem is stripped off in the form of ribbons known as "tuxies." The tuxies are scraped to remove the pulp and other waste material, leaving the cleaned fibre, which is thrn hung up to dry in the open air. Formerly, most of the processing was done by hand; more recently various machines, called decorticators, have been used. Without further treatment the fibre is graded and baled for shipment.

The outer sheaths of the abacá stalk contain a rather short, strong but discoloured fibre; the middle sheaths produce a fibre of medium colour and good strength; the sheaths near the centre of the stalk have a very white, fine fihre of medium strength. Delay and carelessness in drying affect both the colour and the strength of the fibre.

The exceptional strength of abaci fibre and its quality of resistance to the action of salt water make it particularly suitable for marine cordage. It is also largely used for well-drilling cables: hoisting ropes and various other types of rope where strength and durability are required. Henequen and sisal have largely replaced abaci as a binder twine fibre. In the Philippines the superior grades of abaci are used for textile fabrics. hats, slippers, rugs and various other articles. In Japan large quantities of abaci fibre. particularly the waste products. are used for the manufacture of paper. From the old and disintegrated ropes is made the well-known manila paper.

The abaci plant has been introduced into many different tropical regions, including Indonesia, India, the Andaman Islands, the West Indies and Central America; formerly the commercial production of this fibre was confined to the Philippine Islands. About 1921 shipments of abaci rootstocks were made from the Philippine Islands to Sumatra. where fairly large plantings were made. Despite some expansion of the industry there, it remained relatively unimportant. Small abaci plantings were also made in North Borneo.

In 1925 a shipment of propagating material of the superior varieties of abaci was brought from the Philippine Islands to the republic of Panamá by the United States department of agriculture. It was determined by experimental plantings that the climatic and soil conditions of this region are suitable for the abaci plant; that this plant is resistant to the more serious diseases of the banana plant. and that abaci fibre of excellent quality can be produced in tropical America Little attention was given the Central American plantings until 1942 when the war cut off abaci supplies from the Philippines. At that time production of the fibre started in earnest in Costa Rica, Guatemala. Panamá and other countries of Central America.

In the early 1960s world production of abacá fibre exceeded 100,000 long tons, of which total the Philippines contributed over 90%.

(H. T. Es.; X.)

ABACUS, a calculating device of ancient origin still used in parts of the orient and middle east. The first abacus probably was a slab or board on which a Babylonian spread sand so he could trace letters. The word "abacus" is believed to be derived from the Phoenician *abak,* describing sand strewn on a surface for writing. As the abacus came to be used solely for counting and computing, its form was changed and improved Wax-covered boards were introduced. and later a counter abacus was devised in which loose counters of bone, glass or metallic disks or rods were placed on a ruled table drawn on the board. In a still later form. the one used in some parts of the world today the counters slide in grooves or on wires or strings.

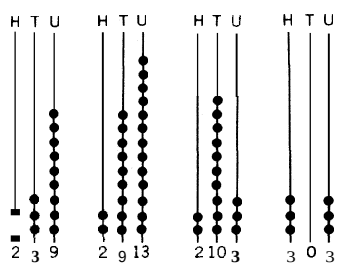


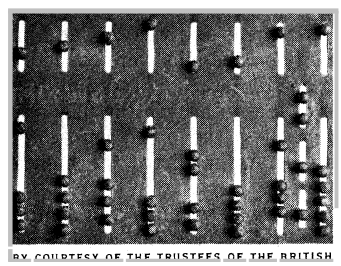
FIG. 1.—ADDITION ON ABACUS AS PRACTISED IN ANCIENT MEDITERRANEAN COUNTRIES

Lines represent hundreds, tens and units. The computation represented is: 239 + 64 = 29[13] = 2[10]3 = 303

The table of the early counter abacus was composed of lines representing units. tens, hundreds, etc., or units of value, such as shillings, pence, pounds. Addition on an abacus of this type probably was performed as represented in fig. 1, which shows the steps in adding 64 and 239. Subtraction was simply the process of taking away counters: multiplication was considered as repeated addition, and division as repeated subtraction. This type of abacus was known in the Mediterranean countries, and Herodotus (c. 450 B.C.) is authority for the statement that the Egyptians wrote their figures and reckoned with pebbles "bringing the hand from right to left," while the Greeks proceeded in the opposite direction.

There are several references to the abacus in Roman literature, and what is apparently a Greek computing table was found in the 19th century on the island of Salamis.

Latin writers tell of three types of abacus in use in Rome, namely: (1) the sand board or wax tablet; (2) a marked table for counters; and (3) a table with grooves in which the counters were free to slide. Fig. 2 shows a late Roman abacus now in the British museum. each upper button representing five units of the order in which the column stands and each lower button representing one unit of the same order. Cicero speaks of the counters as *aera* ("bronzes") but the common name was *calculi* ("pebbles") or *abaculi.* The pieces were stone, ivory, metal or coloured glass.



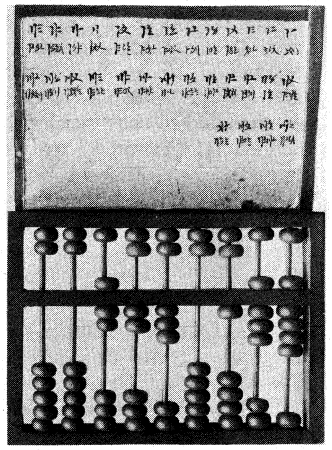
BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM

FIG. 2.—LATE ROMAN ABACUS

Bronze table with each upper button representing five units and each lower button representing one unit of the order in which the column stands

The earliest type of abacus in China seems to have been the bamboo rods that served instead of counters These were known as early as the 6th century B.C. and they survived in Korea until the close of the 19th century. They found their way into Japan

about the year 600 and were known as *sangi* or *sanchu.* Until recent times they were used to represent algebraic coefficients, being placed on a ruled board. Since the 12th century the *suan-pan* ("computing tray"; *see* fig. 3) has been generally used throughout China. The chief difference between this and the Roman abacus lies in the fact that the latter has one less bead in each section. In the 16th century this type, slightly changed and bearing the kindred name of *soroban,* found its way into Japan, where it is still in use. An abacus differing considerably from the Roman or oriental types is found in the middle eastern countries. The Turks call it the *coulba;* the Armenians, the *choreb;* and the Russians, the *s'choty.* As id the case of the *suan-pan* and the *soroban,* this permits rapid computation and serves a purpose similar to that of the modern calculating machine.



ON LOAN TO SCIENCE MUSEUM, LONDON FROM J. YATES, INTERNATIONAL DECIMAL ASSOCIATION

FIG. 3.—CHINESE SUAN-PAN
Each upper bead represents five units and each lower bead represents one unit of the order in which the column stands. The number represented is 7230189

A type of abacus called the line abacus appeared in Europe in the middle ages. It consisted of a table ruled with horizontal lines representing the successive powers of ten, each space between lines representing half the value of the line immediately above it. This type was used well into the 18th century.

Abacus disks used in computing were known in Great Britain as counters; in the Latin books as projectiles *(pro,* "forward," + *jacere,* "to throw"). being thrown or cast upon the counting board, or as *denarii supputarii* ("computing pennies"); and in France as *jetons* (from *jacere,* "to throw"). In Germany a counter was called a *Rechenpfennig* or *Zahlpfennig* ("number penny"). Such later expressions as "cast an account." "borrow one." "carry two" and possibly "lay a wager" have their origin in this kind of computation. The countinghouse, billiard counters! poker chips and various games trace their origin to the counting board.

By medieval times the counter abacus was being used in most regions of the known world, but it gradually was abandoned as the Arabic notation of nine figures and zero replaced the Roman numeral system in calculating. The abacus was last generally used in Spain and Italy in the 15th century, in France in the 16th century and in England and Germany in the 17th century.

(D. E. S.; X.)

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ABACUS, in architecture, the upper member of a capital (*q.v.*) whose function is to provide a supporting surface for the structure above. In Egyptian capitals it is smaller than the parts below and in the late work it has great height. In the Greek Doric order it is a plain square slab. but in the Roman Doric it is usually crowned by a molding. In the Greek Ionic order it is at first rectangular. to cap the projection of the volutes, but later becomes square, except at corner capitals where it is curved out over the angle volutes. In both Greek and Roman Corinthian orders and in the composite and four-sided or Scainozzi Ionic order it is molded with concave sides and usually the corners are cut off slightly. In Romanesque architecture the abacus usually is square, with sides splayed or molded. and in the Gothic, outside of England, it is square or octagonal and richly molded. In English Gothic, however circular forms are frequent especially in 13th-century work. The diminutive, *abaculus,* is applied to the squares of tile, or tessera. *See* also ORDER.

ABADAN, a city of the sixth province or *ostan* (Khuzistan) of Iran, lies on an island of the same name off the eastern bank of the Shatt-al-Arab, 33 mi. from its mouth on the Persian gulf. The island. 42 mi. long and from 2 to 12 mi. wide and known to the Arabs as Jazirat al-Khidr (from the tomb of a saint of that name), is bounded on the east by the Khowr-e Bahmanshir, a branch of the Karun river. The population of Abadan city in 1932 was about 40,000 and by 1956 had reached 226.103, with a further 57.522 in the area. mostly date-palm growers. The climate is extremely hot and often very humid for seven months of the year.

Abadan Island was referred to in the 13th century by the historian Nasir Khosrow as the southernmost settlement of Iraq. Its possession was long in dispute between Persia and Turkey but was awarded to Persia by the treaty of Erzurum (1847); the Turks retained control of the Shatt-al-Arab, while ensuring freedom of navigation to the Persians.

In 1909 the Anglo-Persian Oil company, by agreement with the sheik of Mohammerah, established its pipeline terminus and refinery there. Once the largest in the world, with a daily capacity of 500.000 bbl., it is served by 1,880 mi. of pipelines from the oilfields in the foothills of the Zagros range. The port has deep-water jetties for the loading of tankers and the discharge of other goods. A 590-mi. pipeline to Teheran was completed in 1959. Asphalted roads connect Abadan with the port of Khorramshahr (formerly Mohammerah) and with the oilfields. There is a separate crude oil port at Bandar-e Ma'shur, 55 mi. to the east.

The city is among the best equipped in Iran and consists mainly of a series of compounds for the company's staff and its labour force, which is recruited from all over the gulf and from the Bakhtiari tribes. There is a lively bazaar and poor housing quarters for unemployed immigrants.

The nationalization of the oil industry by the Iranian government in 1951 led to a virtual cessation of operations. Three years later an agreement to resume production was made between the government and a consortium of eight foreign oil companies, but it was not until 1959 that full production was restored.

(H. Bo.)

ABAE, an ancient town in Greece, in the northeastern corner of Phocis, north of Lake Copais and west of modern Topolia. famous for its oracle of Apollo, one of those consulted by Croesus. Its rich treasures were sacked in 480 B.C. by the Persians: who burned the temple. The oracle was. however, still consulted; *e.g.,* by the Thebans before the battle of Leuctra in 371 B.C. The temple. burned again during the Sacred War of 355–347 B.C., was very dilapidated when seen by Pausanias in the middle of the 2nd century A.D., although some restoration had been undertaken by Hadrian. Privileges due to the sanctity of the shrine were confirmed to the people of Abae by the Romans. The polygonal walls of the acropolis may still be seen, with one gateway and traces of town walls below.

ABAILARD: *see* ABÉLARD, PETER.

ABAKAN, the capital of the Khakass autonomous *oblast,* Russian Soviet Federated Socialist Republic. U.S.S.R., was created a town in 1931 and stands on the left bank of the Abakan river at its confluence with the Yenisei. Pop. (1959) 56,000. It is the terminus of the branch railway from Achinsk on the Trans-Siberian; a line from Abakan to Stalinsk in the Kuzbas mas under construction in the 1960s. X branch links Xbakan with the coal-mining town of Chernogorsk, 10 mi. N. X motor road from Abakan crosses the Yenisei to Minusinsk and runs on over the western Sayan mountains to Kyzyl, capital of the Tuva autonomous *oblast.* The town is a centre of metal-working and sawmilling, and of food-processing based on agricultural products of the fertile Minusinsk basin. It has a pedagogical institute.

(R. A. F.)

ABALONE, a common name of Spanish derivation, applied in California to various species of marine snails of the genus *Haliotis.* They are widely distributed and are called perlemeon in South Africa, ormer or ormier in the Channel Islands and France. paua in New Zealand and ear shells in .Australia. The single flattened shell is earlike with the large body whorl perforated on the left side by a single row of small openings that become filled progressively during growth; the last five to nine remain open to serve as outlets for waste products. Depending

on the species, abalones range from a few inches to ten inches across and up to three inches in depth. The lustrous, pearly interior of the shell (see MOTHER-OF-PEARL) is commonly iridescent and is utilized in the manufacture of attractive ornaments such as buttons and inlaying.

The large muscular foot of these snails was a popular food of primitive man and is still regarded as a delicacy in many countries. Commercial fisheries exist in California, Mexico, Japan, South Africa and the Channel Islands off England. The west American species inhabit algal covered rocky bottoms from the tidal zone to depths of more than 100 ft. and are sought by skin divers and commercial fishermen using diving equipment. Of the eight Californian abalones, the red (Haliotis rufescens), pink (H. corrugata) and green (H. fulgens) are the commercially important ones. See also SNAIL.

BY COURTESY OF AMERICAN MUSEUM OF NATURAL HISTORY

SHELL OF BLACK ABALONE (HALIOTIS CRACHERODII), SHOWING BREATHING HOLES

See "Review of the Abalone in California," *Calif. Fish Game,* 46:381–406 (1960). (W. K. E.)

ABANDONMENT, a legal term denoting the relinquishment of an interest, claim or privilege by the owner. The conduct sufficient to manifest an intention to abandon and the consequences of such conduct vary according to the branch of law under which the issue arises. Thus, while the benefit of an easement may be abandoned by the owner of the dominant estate, mere nonuser for a period of time is usually not sufficient to manifest an intention to abandon (see EASEMENT). On the other hand, no matter how clear the intention to abandon an estate in land is expressed, such abandonment is not possible since this would leave the ownership vacant (see REAL PROPERTY AND CONVEYANCING, LAWS OF).

For abandonment of children, see CHILDREN, LAWS CONCERNING; for abandonment of domicile, see DOMICILE AND RESIDENCE. (A. DM.)

ABARBANEL: see ABRABANEL, ISAAC.

ABAS, the name of several characters in classical literature and mythology.

1. Abas, son of Lynceus and Hypermestra (daughter of Danaus), was the 12th king of Argos and founder of Abae in Phocis. He was noted for his shield, which had been consecrated by Danaus to Hera but was given to Abas by his father on his report of Danaus' death. The gift was apparently the explanation of the prize given at an Argive festival, a shield rather than a crown.

2. Three persons by this name appear in Ovid's Metamorphoses: a centaur, a friend of Perseus and a companion of Diomedes who was turned into a swanlike bird by Aphrodite. (T. V. B.)

ABATEMENT, in law, the interruption of a legal proceeding upon the pleading by a defendant of matter which prevents the plaintiff from going forward with the action at that time or in that form. Pleas in abatement raise such matters as objections to the place. mode or time of the plaintiff's action, lack of proper parties to the action or lack of jurisdiction in the court to entertain it, without questioning the justice of the plaintiff's claim. In earlier procedures, abatement of proceedings in equity differed from abatement at law in that the former merely suspended the action, subject to revival when the defect was cured, while the latter entirely terminated it, although the plaintiff could start anew. The latter is now the more usual usage. (C. E. CL.)

ABATTOIR: see SLAUGHTERHOUSE.

ABAUZIT, FIRMIN (1679–1767), French theologian, remembered both for the extent of his learning and for his great kindliness and modesty, was born of Huguenot parents at Uzès in Languedoc in Nov. 1679. His mother contrived his escape to Geneva in 1689 from enforced Catholicism in France. In 1698 he began to travel, visiting Germany, the Netherlands and England and making the acquaintance of learned and literary men, Pierre Bayle and Sir Isaac Newton among them. He declined William III's offer of domicile in England and also the offer (1723) of the professorship of philosophy at Geneva. but in 1727 he was granted citizenship of Geneva and accepted an honorary post as librarian there. He collaborated on a new French version of the New Testament (1726) and wrote the article "Apocalypse" for Diderot's encyclopaedia, but his vast scholarship, which he was more inclined to share with others than to turn to his own profit, extended far beyond Christian doctrine. His theology was of a liberal type. J. J. Rousseau praises him enthusiastically in La *Nouvelle Héloïse.* Abauzit died in Geneva on March 20, 1767.

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ABBADIDS, a Muslim dynasty which arose in Andalusia on the downfall of the caliphate of Cordoba (*q.v.*).

ABBAD I (Abu'l-Qasim Mohammed) (d. 1042) was the qadi of Seville who, in 1023, with aristocratic support, declared his city independent from Cbrdoba. Before his death he had enlarged his territory at the expense of neighbouring kinglets by a mixture of political chicanery and indiscriminate border warfare.

ABBAD II, known as al-Mu'tadid id. 1069), continued this policy of aggrandizement far more successfully by leading Muslims of Arab and native Spanish descent against the Berbers of eastern Andalusia and even aimed at taking Córdoba and restoring the caliphate. He failed in this mainly because of family defections and the opposition of the Castilian king Ferdinand I, whom he later appeased by becoming his tributary. A "vengeful, suspicious and bloody" character, poet and patron of poets, wine drinker and skeptic, he is said to have killed a rebellious son with his own hand and disposed of certain Berber chiefs of Ronda by smothering them in a steam bath in the Alcazar of Seville. Even more sadistically picturesque was his flower garden, planted over the skulls of his enemies, which he "contemplated with ecstasy."

ABBAD III (1040–1095), his son, generally known as al-Mu'tamid, the last ruling member of the dynasty, epitomizes the chivalrous, extravagant and tragic virtuosity of medieval Andalusia Remembered as the poet-king of Seville, whose example and patronage made the city a brilliant centre of Spanish Muslim culture, he appointed as his vizier his fellow poet Ibn Ammar, and took as his queen a Sevillian slave girl, I'timad al-Rumaykiyah, who had capped one of his improvised couplets. Though he was a less ruthless character than his father, his political life. was equally turbulent and scarred by repeated tragedies and failures. His son and namesake was killed in early youth during a struggle with the ruler of Toledo for possession of Córdoba. His alliance with the Catalans for the conquest of Murcia was destroyed by an unforeseeable mishap, and the conquest of that city by his troops led to a breach with Ibn Ammar. who lampooned his master so stubbornly that he had him strangled in jail. Al-Mu'tamid's downfall was precipitated by the outbreak of hostilities against the Castilian king Alfonso VI, whose Jewish envoy had accused al-Mu'tamid of debasing the tribute money. Al-Mu'tamid had him crucified, and in revenge Alfonso made a fruitless incursion into Andalusia. Christian progress in Aragon and Valencia and the fall of Toledo in 1085, together with pressure from religious enthusiasts at home, forced al-Mu'tamid to seek alliance with the Almoravid amir Yusuf ibn Tashfin (see ALMORAVIDS). Although the Sevillian had distinguished himself for generalship and personal valour in their joint victory in 1086 over the Castilians in the battle of Zallaka or Zalaca (Sacralias, north of Badajoz), the Almoravid later turned against his ally and besieged Seville. The city was betrayed by Muslim zealots after a heroic defense by al-Mu'tamid, who was taken prisoner (1091). Some of the elegies he wrote in his five-year captivity in north Africa won him popular sympathy, and for more than two centuries his tomb was a centre of pilgrimage.

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ABBADIE, ANTOINE THOMSON D' (1810–1897), and **ARNAUD MICHEL D'** (1815–1893), geographers and travelers in north Africa who were born in Dublin, Ire., of a French father and an Irish mother. Their parents moved to France in 1818. In 1835 the French Academy sent Antoine on a scientific mission to Brazil, the results being published in 1873 under the title of *Observations Relatives à la Physique du globe faites au Brésil et en Éthiopie.* Arnaud spent some time in Algeria before the two brothers started for Abyssinia in 1837, landing at Massawa in Feb. 1838. After collecting much information on the geography, geology, archaeology and natural history of Abyssinia, the brothers returned to France in 1848. Arnaud then paid another visit to Abyssinia in 1853.

Meanwhile Antoine had become involved in various controversies relating to both his geographical results and his political activities in Abyssinia. Time and the investigations of subsequent explorers have shown that he was quite trustworthy as to his facts, though wrong in his contention that the Blue Nile was the main stream. The topographical results of his explorations were published in Paris in 1860–73 in *Géodésie de l'Éthiopie.* Of the *Géographie de l'Éthiopie* (1890) only one volume has been published. *Un Catalogue raisonné de manuscrits e'thiopiens* (1859) contains a description of 234 Ethiopian manuscripts collected by Antoine. He published numerous papers dealing with the geography of Abyssinia, Ethiopian coins and ancient inscriptions. His *Reconnaissances magnétiques* (1890) is an account of the magnetic observations made by him in journeys to the Red sea and the Levant.

The general account of the travels of the two brothers was published by Arnaud in 1868 under the title of *Douze ans dans la Haute-Éthiopie.* Antoine died in 1897 and bequeathed an estate in the Pyrenees, yielding 40,000 francs a year, to the Academy of Sciences. on the condition that it produce a catalogue of 50,000 stars within 50 years. His brother Arnaud died in 1893.

ABBA MARI (ABBA MARI BEN MOSES BEN JOSEPH), French rabbi, was born at Lunel, near Montpellier, toward the end of the 13th century. He is also known as Yarhi from his birthplace (Heb. *Yerah; i.e*, "moon," *lune),* and he further took the name Astruc, Don Astruc or En Astruc of Lunel. In Montpellier, where he lived from 1303 t~ 1306, he was much distressed by the prevalence of Aristotelian rationalism, which, through the medium of the works of Maimonides, threatened the authority of the Old Testament, obedience to the law, and the belief in miracles and revelation. He, therefore, in a series of letters (afterward collected under the title *Minhat Kenaot;* "Jealousy Offering") called upon the famous rabbi Solomon ben Adret of Barcelona to come to the aid of orthodoxy. Ben Adret, with the approval of other prominent Spanish rabbis, sent a letter to the community at Montpellier proposing to forbid the study of philosophy to those who were less than 30 years of age, and, in spite of keen opposition from the liberal section, a decree in this sense was issued by Ben Adret in 1305. The result was a great schism among the Jews of Spain and southern France, and a new impulse was given to the study of philosophy by the unauthorized interference of the Spanish rabbis. On the expulsion of the Jews from France by Philip IV in 1306, Abba Mari settled at Perpignan, where he published the letters connected with the controversy.

BIBLIOGRAPHY.—Edition of the *Minhat Kenaot* by *M. L.* Bislichis (1838); E. Renan, *Les rabbins français,* p 647 ff ; Perles, *Salomo ben Abraham ben Adereth,* p. 15–54; "Abba Mari," *Jewish Encyclopedia*

ABBAS I (1571–1629), shah of Persia from 1587 to 1629, is known as Abbas the Great. His brutal uncle Isma'il II ordered his execution when he was a child, but he was saved by Isma'il's death in 1577. Four years later he was proclaimed ruler of the great province of Khurasan. He became shah of Persia on the abdication of his father, Mohammed Khudabanda, in 1587. His prospects seemed gloomy, as he was confronted with anarchy in Persia due to the insubordination of the Turkmen tribal leaders, and with invasion by the Ottoman Turks on the west and by the Uzbeks on the northeast.

Faced with such odds, Abbas was forced to make peace with the Turks on unfavourable terms in 1599, but he was then able to subdue the rebels in his own country and to crush the Uzbeks and drive them out of Persia. He reopened hostilities with Turkey in 1603 and in a series of campaigns regained the territory that had been surrendered in 1599; the war against the Turks continued, with intervals, until the end of his reign. In 1621 his forces regained Kandahar, which the Mogul emperor Akbar had seized 30 years earlier. In the following year, with naval aid furnished by the English East India company, Abbas expelled the Portuguese from the island of Hormuz; much of the trade from there was diverted to Gombrun on the mainland, which was renamed Bandar 'Abbas after the shah. In gratitude for the East India company's assistance against the Portuguese, the shah gave the company valuable privileges at Bandar 'Abbas.

Abbas' military successes were largely the result of his thorough reorganization of the army. In place of the tribal levies, whose loyalties were primarily to their own chiefs, he created a regular force, which gained both in reliability and in efficiency. In this he owed much to the help of an English adventurer, Sir Robert Shirley (Sherley), who also assisted him in the creation of an artillery corps. Abbas' reign was distinguished by military successes and administrative efficiency, also by the magnificence of his court and by his zeal as a builder. He largely replanned and rebuilt Isfahan, which he had made his capital in 1598; many of the architectural glories of that city date from his reign. He fostered trade and industry by constructing highways, bridges and caravanseries and also by granting privileges to his Armenian subjects (many of whom he had forcibly moved from their homes in the north and settled in a suburb of Isfahan). He also encouraged the English and Dutch East India companies to trade in Persia. He was tolerant in religious matters and allowed foreign monastic orders to establish missions in Persia.

Abbas' fame, however, was tarnished by some terrible deeds of cruelty. At his orders Queen Ketevan of Kakhetia mas tortured and put to death. He blinded and imprisoned his father and two brothers and had his own son Mohammed Baqir Mirza executed and another son, Imam Quli, blinded. Although he had made Persia a great power once again, he was nevertheless partially responsible for its subsequent decline by reason of his inauguration, for reasons of security, of the practice of immuring the heir apparent (as well as the other royal princes) in the harem until the moment came for his accession to the throne.

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(L. Lo.)

ABBAS I (1813–1854), pasha and viceroy of Egypt, a grandson of Mohammed Ali (*q.v.*), came to power in 1849, nine months after the death of his uncle Ibrahim Pasha. Abbas was by nature cautious and secretive. His years of office were marked by reaction against the westernizing tendencies of Mohammed Ali; he curtailed the scope of government activity. reduced the fighting services, closed factories and abolished, though only partially in the Sudan, the state trading monopoly imposed by his grandfather in defiance of Ottoman treaties with the Powers. He distrusted western, especially French, thought and ways and dismissed many European experts. while Egyptian intellectuals influenced by European culture, such as Rifa'a Bey al-Raf'i, were banished to the Sudan. Nevertheless his retrenchment in government spending lightened taxation and restored the Egyptian finances, strained by Mohammed Ali's wars and economic experiments. Abbas permitted the construction of the Alexandria-Cairo railway by Robert Stephenson (1852–56). His loyalty to the Ottoman empire was expressed by the dispatch of an Egyptian contingent in 1853 to support the Turks against the Russians (*see* CRIMEAN WAR). On July 13. 1854, he was murdered at Benha. (R. L. HL.)

ABBAS 11 (ABBAS HILMI PASHA) (1874–1944), last khedive of Egypt. was born in Cairo on July 14, 1874, the eldest son of Mohammed Tewfik (Tawfiq) Pasha, whom he succeeded in the khediviate in 1892. His relations with the British occupying power were invidious. With studied indiscretion at a parade of troops at Wadi Halfa during a tour of the frontier garrisons in 1894, he publicly criticized the military efficiency of the British officers

serving in the Egyptian army, an incident which caused the fall of the Riyad ministry and brought no gain to his prestige in any quarter. His dealings with the Egyptian nationalists were equally unfortunate. So long as nationalist criticism was confined to agitation against the British occupation, he discreetly supported the nationalist cause and in 1904 procured from the sultan the grade of pasha for the nationalist leader Mustafa Kamil, who for a time pursued a pan-Islamic and pro-Ottoman policy. When, however, partly as a result of the Anglo-French settlement of 1904, the nationalists began to advocate a more liberal regime for Egypt, their relations with the khedive became estranged.

Abbas showed a lively interest in the social and economic welfare of Egypt and the Sudan. He visited Berber and Khartoum in 1901–02 and opened the new harbour at Port Sudan in 1909. While on a visit to Constantinople he was shot and wounded by an Egyptian student in July 1914. He was still in Turkey when the Ottoman empire entered World War I; his return to Egypt was forbidden by the British, who declared a protectorate over Egypt and, on Dec. 19, 1914, deposed him in favour of his uncle, Husain Kamil Pasha, who assumed the title of sultan. Abbas passed the rest of his life in exile, chiefly in Switzerland, and died at Geneva on Dec. 21, 1944. He wrote *A Few Words on the Anglo-Egyptian Settlement* (1930).

See Evelyn Baring, earl of Cromer, Abbas ***II*** (1915); A. A. H. Beaman, ***The Dethronement*** of ***the Khedive,*** ed., with introduction, by J. M. Robinson (1929). (R. L. HL.)

ABBAS, FERHAT (1899–), Algerian political leader of the Front of National Liberation (F.L.N.) in the Algerian rebellion against French rule, was born at a village near Djidjelli in the Constantine department. Son of a caid, he was educated at Philippeville and later at Algiers university. Entirely French-educated, he never spoke Arabic well. After two years' service with the French army, he became a pharmacist at Sétif and later a member of the *conseil général* of Constantine. In his first period of political activity Abbas stood for the emancipation of the Algerian Muslims as French citizens. "Algeria is French soil," he wrote in 1931, "and we are French Moslems." As late as 1936 he declared that he had interrogated the living and the dead and found no one who mentioned an Algerian nation. Bitterly disillusioned by the subsequent French rejection of the proposals in the Blum-Violette plan, he yet served as a volunteer with the French forces in World War II from 1939 until the fall of France in 1940. Later he promoted the "Algerian manifesto" which was presented to the allied leaders in Algeria in 1942 and, in a modified form, accepted for discussion by the French authorities in 1943. In its final form this envisaged an Algerian state at the end of the war, with a constitution to be worked out by a constituent assembly elected by universal suffrage; meanwhile a government should be formed with Muslim and European members in equal numbers and parity be established in all assemblies. As leader of the Union Démocratique du Manifeste Algérien and member of the French constituent assembly, he submitted in Aug. 1946 a project for the recognition of Algeria as a state federated with France. This, however, was not considered by the assembly. On the outbreak of the rising in 1954, he appeared at first taken aback and issued an appeal for calm. Later, however, with other former moderates of various tendencies, he escaped to Cairo and joined the Front of National Liberation (April 1956). On Sept. 19, 1958, the formation of a provisional government of the Algerian republic was announced in Cairo, with Ferhat Abbas as prime minister. (N. BA.)

ABBASIDS, the second of the two great dynasties of the Moslem Arab empire *(see* CALIPHATE). The name is derived from Mohammed's uncle, al-Abbas (566–652), of the Hashemite clan of the tribe of Quraysh in Mecca. From *c.* 718 some of the family of al-Abbas were planning to gain supreme power. By skillful propaganda their agents won much support, especially from Arabs and Persians in Khurasan. Open revolt in 747 under Abu Muslim led in 750 to the defeat of the Omayyad dynasty and the proclamation of the first Abbasid caliph, Abu'l-Abbas.

Iraq became the centre of the caliphate instead of Syria, Baghdad being founded as capital *c.* 762. Much of the support of the Abbasids came from Persian converts, and it was therefore natural for them to take over much of the Persian (Sassanian) tradition of government. Support by pious Muslims likewise led them to acknowledge publicly the embryonic Islamic law and to profess to base their rule on the religion of Islam. Under them commerce and the liberal arts expanded. The reigns of Harun al-Rashid (786–809) and al-Ma'mun (813–33) were periods of splendour.

Gradually Abbasid power decayed. First in the east, then elsewhere, provincial governors made themselves independent though still nominally receiving appointment from the caliph. In the 10th century, real power even at the centre passed into the hands of dynasties of military leaders, such as the Buyids and the Seljuks (*qq.v.*). The caliph retained the nominal power of making appointments while these rulers had titles such as sultan. This nominal power was ended in 1258. A branch of the family held formal, religious powers in Cairo until the death in 1538 of al-Mutawakkil III who had been moved to Istanbul in 1517. *See* also Index references under "Abbasids" in the Index volume. (W. M. WT.)

ABBE, ERNST (1840–1905), German physicist, is best known for his invention of the Abbe refractometer and his many improvements in microscopic and photographic lenses. He was born in Eisenach, Thuringia, Jan. 23, 1840. He was educated at Gottingen and Jena. In 1863 he became an instructor, and in 1870 was made a professor, in the University of Jena, at which in 1878 he was appointed director of the astronomical and meteorological observatories. In 1866 he became connected with the optical works of Carl Zeiss, was made a partner in 1875, and contributed in a very large degree through his experiments to the excellence of the instruments and lenses made by the firm.

In 1884, with Zeiss and Otto Schott, he established important works for the production of technical glass. Upon the death of Zeiss in 1888 he became the sole owner of the Zeiss optical works, which he reorganized as a co-operative establishment; the officials, the workmen and the university participated in its profits. His collected works were published in 1903–06. He died in Jena, Jan. 14, 1905.

ABBESS: *see* ABBOT.

ABBEVILLIAN (formerly known as CHELLEAN [*q.v.*]), the oldest Stone Age industry with hand axes, named after Abbeville in the Somme valley, France, where it occurs in terrace gravels believed to date from the first warm interval in the Pleistocene Ice Age, *i.e.*, more than 300,000 years old. These simple tools, also called *bifaces* or *coups de poing*, consist of a lump of flint or other suitable stone flaked to a tongue-shaped form with a margin for cutting, and may be pointed or oval. Abbevillian hand axes are coarsely flaked (probably with hammerstone) and have a thick, largely unworked butt. Lower Paleolithic hand-ax culture spread throughout Africa, western Europe and southwestern Asia. The development of hand axes from roughly chipped pebbles has been traced in Oldoway (Olduvai) gorge in Tanganyika. The Abbevillian type was superseded by the more regularly flaked Acheulian hand axes, associated with Ternifine and Swanscombe man. *See* also ARCHAEOLOGY. (K. P. O.)

ABBEY, EDWIN AUSTIN (1852–1911), U.S. painter, one of the foremost illustrators of his day, was born in Philadelphia, Pa., April 1, 1852. After studying at the Pennsylvania Academy of Fine Arts, he became in 1871 an illustrator for the publishing house of Harper and Brothers in New York. Harper's, because of his success, was persuaded to send him to England in 1878 to gather material for illustrations of the poems of Robert Herrick. These drawings, published in 1882, and followed by illustrations for Oliver Goldsmith's *She Stoops to Conquer* (1887), *Old Songs* (1889), and the comedies of Shakespeare, among others, established his reputation in England and America. His water colours and pastels were no less successful, and he was elected a member of the Royal Institute of Painters in Water-Colours in 1883. He first exhibited an oil painting at the Royal Academy in London in 1890; he was elected an associate (A.R.A.) in 1896, academician (R.A.) in 1898, and to the National academy in 1902.

In his later years he created several large decorative schemes, including murals in the Boston public library and in the state capitol at Harrisburg, Pa. He painted the official picture of the

coronation of Edward VII in 1902 and supervised the decoration of the peers' corridor of the houses of parliament just before his death. Aug. 1, 1911. His work, especially his perceptive drawings, water colours and sketches, was of consistently high academic quality. At his finest he achieved a degree of spontaneity and life seldom attained by artists of this persuasion. He is represented by works at the Metropolitan Museum of Art, New York; the Boston Museum of Fine Arts; Carnegie institute, Pittsburgh; and the Tate gallery, London. The Yale University Art gallery, New Haven, Conn., possesses a large collection of his work.

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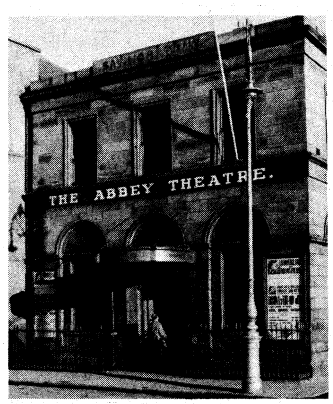
ABBEY THEATRE, the national theatre of Ireland, began in 1902 when the Irish Literary theatre's work in Dublin was taken over by W. G. Fay's Irish National dramatic company, which presented Irish plays with Irish actors. In 1903 it became the Irish National Theatre society. This brought W. B. Yeats, J. M. Synge, Lady Gregory, George William Russell (A?) and others into contact with the group of amateur actors which the brothers Frank and William Fay had been building up since 1891.

In 1904 an Englishwoman, bliss A. E. F. Horniman (*q.v.*), paid for the conversion of an old theatre and adjoining buildings into the Abbey theatre. Its early years were tempestuous. Synge's *The Playboy of the Western World* (1907) was greeted with almost riotous disorder. Tension and quarrels with the directors caused the resignation of the Fays later the same year—the chief but not the only schism of the early period. Two years later Miss Horniman withdrew her subsidy, by which time the company was strong enough to carry on. Lennox Robinson (*q.v.*) joined the management in 1910. He was active as dramatist, manager and director for more than 40 years and next to Lady Gregory (*q.v.*) did most to keep the Abbey going from 1916 to 1924, when the government subsidy was first given. Sean O'Casey brought a change in luck, and his plays, produced between 1923 and 1926, gave a splendid opportunity to a new generation of actors. George Shiels wrote plays from 1921 until his death in 1949, and Brinsley MacNamara. Paul Vincent Carroll and Denis Johnston made important contributions in the 1930s.



W. SUSCHITZKY

THE ABBEY THEATRE, DUBLIN. IRE., DESTROYED BY FIRE JULY 18, 1951

The Abbey's contribution to the world theatre is divided between a school of playwrights and a style of acting which abolished the "stage Irishman." Its plays are presented mainly in English but a few are in Irish. After a fire in 1951 the company moved to the Queen's theatre nearby. Plans were published (1958) for a larger theatre on the original site.

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ABBON, SAINT, OF FLEURY (ABBO) (*c.* 930–1004), French Benedictine monk and scholar, who led a vigorous movement for monastic reform, was born near Orleans. In 985 he was invited to England to establish the monastery school at Ramsey. After his return to France, Abbon was elected abbot of Fleury on the Loire (988). He played a leading role at the synod of St. Basle where Archbishop Arnolf was tried for treason and deposed. At the monastery of La Réole in Gascony, he tried to re-establish strict Benedictinism by bringing in a group of his own reform monks. The original group at the monastery revolted against the reformers, and Abbon was killed during the ensuing fracas. His feast day is Nov. 13.

Abbon's life, written by his friend and disciple, Aimoin of Fleury (and reprinted in J. P. Migne. *Patrologia Latina,* vol. cxxxix, pp. 375–414), is an important source for the reign of Robert II of France.

See Dom Patrice Cousin, *Abbon de Fleury-sur-Loire* (1954). (E. G. RN.)

ABBOT, EZRA (1819–1884), U.S. biblical scholar, whose studies were chiefly in oriental languages and the textual criticism of the New Testament, though he was a remarkable bibliographer, was born at Jackson, Me., April 28, 1819. He graduated at Bowdoin college in 1840, and, after being principal of a public school in Cambridge, became assistant librarian of Harvard university. From 1872 until his death, on March 21, 1884. he was Bussey professor of New Testament criticism and interpretation in the Harvard divinity school.

Abbot's publications were largely dispersed in the pages of reviews and other publications. but to the enlarged American edition of Smith's *Dictionary of the Bible* (1867–70) he contributed more than 400 articles, besides greatly improving the bibliographical completeness of the work. His principal single production, representing his scholarly method and conservative conclusions, was *The Authorship of the Fourth Gospel* (1880; second edition, by J. H. Thayer, with other essays, 1889), up to that time probably the ablest defense, based on external evidence, of the Johannine authorship, and certainly the most complete treatment of the relation of Justin Martyr to this gospel. Abbot also was one of the original members of the American New Testament Revision company in charge of the Revised Version of the Bible.

See S. J. Barrows, *Ezra Abbot* (1884).

ABBOT, GEORGE (1562–1633), archbishop of Canterbury and the recognized leader of the Calvinists during the early years of the 17th century, was born on Oct. 19, 1562, at Guildford. Surrey, the son of a clothworker. Educated at Balliol college, Oxford, he became master of Gniversity college (1597) and dean of Winchester (1600). He was vice-chancellor of the university of Oxford at different times between 1600 and 1605, when his theological views brought him into conflict with Laud. He wrote *A Briefe Description of the Whole Worlde* (1599), *An Exposition upon the Prophet Jonah* (1600), and helped to prepare the Authorized Version of the New Testament (1611). James I sent him to Scotland in 1608 to arrange for the establishment of episcopacy there. In 1609 he became bishop of Lichfield and Coventry, in 1610 of London and in 1611 archbishop of Canterbury. He promoted the marriage between the elector palatine and Princess Elizabeth and resisted the proposal for the marriage of the prince of Wales to the Spanish infanta. In 1621 he accidentally shot a keeper while hunting. The question whether the homicide, though accidental, disqualified him from office was referred to a commission, on which King James exercised the casting vote in his favour. Under Charles I he was suspended from his functions as primate for refusing to license the assize sermon of Robert Sibthorp at Northampton (Feb. 22, 1627) advocating nonresistance to the royal demands, however arbitrary. He died at Croydon, Aug. 4, 1633. (G. HU.)

ABBOT, WILLIAM (1789–1843), English actor, of whom William Hazlitt said, "he never acts ill," was born in Chelsea, London, and made his first appearance on the stage at Bath in 1806, and his first London appearance in 1808. He created the parts of Appius Claudius in Sheridan Knowles's *Virginius* (1820) and of Modus in his *Hunchback* (1832). In 1827 he organized the company, including William Charles Macready and Harriet Constance Smithson, which played Shakespeare in Paris. Abbot's two melodramas. *The Youthful Days of Frederick the Great* (1817) and *Swedish Patriotism* (1819), were produced at Covent Garden. He died in poverty in Baltimore, Md., on June 6, 1843. (W. J. M.-P.)

ABBOT, is the officialtitle of the superior of a monastic community that follows the Rule of St. Benedict (Benedictines [*q.v.*], Cistercians, Camaldolese, Trappists) and of certain orders of canons regular (Premonstratensians, Canons Regular of the

Lateran). The word derives from the Aramaic ab, aba ("father," "my father"), which in the Septuagint and Yew Testament Greek was written abbas. In early Egyptian monastic history, monks renowned for age and sanctity were called abbas by their disciples. The word signified the spiritual fatherhood which, according to the Scriptures of both Testaments, he exercises who teaches divine wisdom (*e.g.*, I Cor. iv, 15). This father-son relationship between Christian teacher and disciple was also recognized in nonmonastic circles—*e.g.*, by Irenaeus, Clement of Alexandria, Origen, etc.—and led to the term "Father" being applied subsequently to important early Christian writers. Originally, therefore, the title did not have the connotation of authoritative ruling. When monasticism in the east became more organized, under Pachomius and Basil, and more stress was correspondingly laid on the power of jurisdiction, the superiors of such monasteries were called not abbas but *proestos; i.e.,* "he who rules." Its Latin equivalent, *praepositus,* was adopted in western monasticism by Cassian.

It was Benedict, in his "Rule for Monks," who restored the word abbas, the abbot being regarded as the representative of Christ in the monastery, who teaches and instructs in Christ's name. To this earliest concept of spiritual fatherhood through teaching, connoted by the word abbot, Benedict added the concept of *patria potestas,* the authority wielded by a father according to Roman law. The abbot has the fullness of authority to rule the monastery in temporal as well as spiritual matters; and the monks. his sons. owe him the typically Roman virtues of reverence, obedience and filial piety. The abbot's rule may therefore rightly be called monarchic. Yet it is also clearly constitutional, for the abbot himself is bound by the Rule, details of which, however, he may adapt according to changing needs. In the course of the centuries the Rule was supplemented by decrees of popes and councils, and more recently by the Code of Canon Law. Yet the supremacy of the abbot and his government of the monastery has never been seriously weakened.

Abbots at first were laymen, hut beginning about the 5th century in the east, and, under the influence of that example, in the 7th century in the west, only an ordained priest was normally elected abbot. This became mandatory through a council of Rome in 826.

The Rule of St. Benedict stipulates that the abbot be elected by the monks of the monastery. As the monasteries became more and more influential, however, bishops and secular rulers often interfered and claimed the right to name abbots, or appointed abbots *in commendam; i.e.,* persons who were granted the temporal revenues of the monastery. This latter abuse continued in some countries into the 18th century. It was so entrenched that every ecclesiastic of any standing possessed an abbey or two in *commendam,* and was therefore a commendatory "abbot." Hence it became customary to presume this honour in all ecclesiastics, and, in France, to address every priest as *Monsieur l'Abbé.*

As a protection against such encroachment, abbeys secured from Rome exemption from the jurisdiction of the local bishops, and also united in so-called "congregations." Such congregations become the norm in the 14th century, but the autonomy of the individual abbey, and correspondingly the authority of the abbot, were nonetheless jealously guarded, especially among the "black monks," the Benedictines. In 1893 Pope Leo XIII united all the Benedictine congregations into a federation presided over by an abbot primate who resides in Rome and has certain supervisional rights over the discipline of the abbeys. By the Lex *Propria* of 1947, the abbot primate's privileges and obligations were more closely defined. The Reformed Cistercians, or Trappists, were similarly federated under an abbot general in 1892.

According to law. an abbot is elected by the chapter of the monastery in secret ballot. He must be at least 30 years old, of legitimate birth, professed at least ten years and an ordained priest. An abbot is elected for life except in the English congregation, where by special dispensation he is elected for a term of 8–12 years. The election must be confirmed by the Holy See or by some other designated authority. The bishop of the diocese in which the monastery is situated confers the abbatial blessing. assisted by two abbots. This solemn rite, found in the Roman Pontifical and dating back in part to the 8th century, strikingly resembles the consecration (*q.v.*) of a bishop, including a laying on of hands. Though not a sacrament, it is regarded as one of the most important sacramentals of the Roman Catholic Church because of the privileges and powers it confers. Chief among these are the power to administer tonsure and the four minor orders on his own subjects, and the right to celebrate Mass according to pontifical rite, to give many of the blessings normally reserved to a bishop, and to use the pontifical insignia of mitre, crosier, pectoral cross and ring.

Some abbots have ordinary jurisdiction over a given territory and govern it as a bishop does his diocese. They may administer confirmation, but, unless in episcopal orders, may not confer the major orders. Such an abbot is called abbas *nullius* (dioecesis); *i.e.*, abbot belonging to no diocese. Archabbot is a title borne by abbots of certain distinguished monasteries.

In eastern monasticism, the superior of a community of cenobite monks is called archimandrite (*q.v.*) or hegumen. Idiorrhythmic (*i.e.,* "self-governing") monasteries, which made their appearance in the 14th century, are ruled by several elder monks whose leader is given the name of abbot. The election of a monastic superior is confirmed by the diocesan bishop, who also officiates at the blessing. Abbatial insignia include the *mandyas* (similar to the western *cappa magna*) and the *pateritsa,* the pastoral staff.

Abbess is the title given to the superior of certain communities of nuns following the Benedictine Rule, of convents of the Second Franciscan order (Poor Clares) and of certain communities of canonesses The name is met with for the first time on a Roman inscription of 514. To be elected, an abbess must be at least 40 years old and a professed nun at least ten years. She is solemnly blessed by the diocesan bishop in a rite resembling that of the blessing of abbots. Her blessing gives her the right to specified pontifical insignia: the ring and, sometimes, the crosier. In medieval times, abbesses occasionally ruled double monasteries, of monks and nuns, and enjoyed various privileges and honours.

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ABBOTSFORD, the country seat of Sir Walter Scott (*q.v.*) from 1812 till his death in 1832. lies 3 mi. W. of Melrose. Roxburghshire, Scot. Scott bought, in 1811, from the Rev. Robert Douglas of Galashiels, a farm of 110 ac. on the right bank of the river Tweed opposite Galashiels. He renamed the land Abbotsford. By successive purchases he enlarged it to 1,200 ac., much of which he planted with trees. To the original farmhouse he built (1817–19) a Gothic addition which he extended (1822–25) over the site of the old house, which was pulled down. Although he consulted Edward Blore, Daniel Terry and others, he himself superintended the planning and building of the house, employing as architect William Atkinson. In 1823 Scott installed a gas plant to light the house with oil gas. James Hope-Scott added a south wing in 1855. The house, still owned and occupied by Scott's direct descendants, is furnished substantially as it was in Scott's day and contains a valuable collection of books and historic relics. It is open to the public from March to October. (J. C. Co.)

ABBOTT, GRACE (1878–1939), U.S. social worker and reformer, influenced public opinion in favour of the child-labour amendment and related social legislation. She was born in Grand Island, Neb.. Nov. 17, 1878, and educated at Grand Island college and The University of Chicago. In 1908 she went to Hull House. Chicago, as director of the newly formed Immigrants' Protective league. She exposed the exploitation of immigrants in a series of weekly articles ("Within the City's Gates") in the Chicago Evening Post (1909–lo), in articles in the Journal of *Criminal* Law and Criminology (1911 and 1915) and in her book

The Immigrant and the Community (1917). As director of the child-labour division, U.S. Children's bureau (1917–19), she administered the first federal child-labour law. As chief of the bureau (1921–34) she administered the Maternity and Infancy act (1922–29). She was U.S. delegate to the International Labour organization in 1935 and 1937. While serving as professor of public welfare at The University of Chicago (1934–39) she edited the *Social Service Review* and published *The Child and the State,* 2 vol. (1938). Some of her papers were published posthumously under the title *From Relief* to *Social Security* (1940). She died in Chicago on June 19, 1939.

Her sister, Edith Abbott (1876–1957), was dean of The University of Chicago school of social service administration from 1924 to 1942. She died in Grand Island, July 28,1957. (A. W. M.)

ABBOTT, JACOB (1803–1879), U.S. teacher and writer, was best known for his many books for young readers, including the "Rollo" series. Born at Hallowell, Me., on Nov. 14, 1803, he and his four brothers all attended Hallowell academy and Bowdoin college (Brunswick, Me.), studied at Andover Theological seminary (Andover. Mass.), and became teachers and ministers. After teaching at Amherst college (Amherst, Mass.), Abbott, in 1829, moved to Boston where he founded and was the first principal of the Mount Vernon school, a secondary school for girls. *The Teacher* (1833), which pioneered in advocating an appeal to students' honour and conscience in place of traditional disciplinary methods, was widely used as a textbook in early teacher-training institutions. In 1833 Abbott left Boston for suburban Roxbury, where his third son, Lyman Abbott (*q.v.*), was born. He devoted his time chiefly to writing. Later he established a home at Farmington, Me., where he died on Oct. 31, 1879.

He was sole author of 180 books, and co-author or editor of 31 others, notably the "Rollo" series (28 vol.). To accompany the earlier books (*Rollo at Work, Rollo at Play*), Abbott wrote a volume for teachers, *The Rollo Code of Morals, or the Rules of Duty for Children, Arranged With Questions for the Use of Schools* (1841). In following Rollo's travels about the world, with his all-knowing Uncle George, the young reader could improve himself with information on ethics, geography, science and history. Abbott also wrote 22 volumes of biographical histories and the *Franconia Stories* (10 vol.).

BIBLIOGRAPHY.—The memorial edition of *The Young Christian* (1882) contains a biographical sketch by his son Edward Abbott; Lyman Abbott, *Silhouettes of My Contemporaries* (1921); Carl J. Weber, *Bibliography of Jacob Abbott* (1948).

ABBOTT, LYMAN (1835–1922), U.S. Congregationalist minister, was editor for almost half a century of the *Outlook,* and influential as a leading exponent of the Social Gospel. He was born at Roxbury, Mass., on Dec. 18, 1835, the son of Jacob Abbott (*q.v.*). He graduated from New York university in 1853, studied law and was admitted to the bar in 1856, left the practice of law to study theology and was ordained a minister in 1860. After serving in two pastorates he became associate editor of *Harper's Magazine* and in 1870 editor of the *Illustrated Christian Weekly.* In 1876 he joined Henry Ward Beecher as associate editor of the *Christian Union,* an undenominational religious weekly founded by Beecher, and in 1881 became editor in chief. After Beecher's death, he succeeded in 1888 to his pulpit in the Plymouth Congregational church, Brooklyn, where he served until resigning in 1899.

Abbott early became interested in industrial problems. Under his editorship the *Outlook* (as the *Christian Union* was renamed in 1893) became the first leading religious journal to enter into a discussion of labour problems, both editorially and through the contributions of such economists as Elp and such ministers as Washington Gladden (*q.v.*). With Gladden and Walter Rauschenbusch (*q.v.*), Abbott was a leader in presenting the Social Gospel, which sought to interpret Christianity in terms of practical applications to industrial and social problems. His *Christianity and Social Problems* (1897). *The Rights of Man* (1901), *Industrial Problems* (1905), *The Spirit of Democracy* (1910) and *America in the Making* (1911) present his sociological views, which were middle-of-the-road, opposed both to socialism and to *laissez-faire* economics *(see* CHRISTIAN SOCIALISM).

On other problems Abbott led in presenting the viewpoint of liberal evangelical Protestantism. He sought to interpret rather than condemn the impact of the theory of evolution on religion. Abbott also popularized the point of view of "higher criticism." Among several popular devotional books, *The Other Room* (1903) and *The Great Companion* (1904) are notable. He published *Reminiscences* (1915; new ed. 1923). As editor he supported Theodore Roosevelt's presidential campaign of 1912, and early recognized as inevitable the entrance of the U.S. into World War I.

Abbott died in New York city, Oct. 22, 1922.

BIBLIOGRAPHY.—Character sketches and tributes in the *Outlook* (Nov 8, 1922); Ira V. Brown, *Lyman Abbott, Christian Evolutionist: A Study in Religious Liberalism* (1953), containing extensive bibliography; C. H. Hopkins, *The Rise of the Social Gospel in American Protestantism 1865–1915* (1940).

ABBOTTABAD, headquarters of Hazara district and a military cantonment, lies 38 mi. N.N.E. of Rawalpindi. Pop. (1951) 27.617, including 14,163 in cantonment. Total area 7 sq mi. Abbottabad lies 4,120 ft. above sea level on a saucer-shaped plateau at the southern corner of the Rash or Orash plain with the snow-covered Kagan and Bhogarmang to the north and the wooded hills of Thandiani and the Galis to the east. It contains a men's and a women's college affiliated with Peshawar university and two public parks. It is the chief market town for the surrounding countryside and lies on the main road running from the Indus plainlands of Campbellpur district northeastward to the Kagan valley and Srinagar (Kashmir). The railhead is Havelian (10 mi. S.), the end of a branch line from Taxila on the Lahore-Rawalpindi-Peshawar main line. At Kakul (5 mi. N.E.) is the Pakistan military academy. Abbottabad was founded in 1853 and named after Maj. James Abbott, the first British deputy commissioner of Hazara. (K. S. AD.)

ABBREVIATION. Strictly a shortening, the word abbreviation commonly refers to a letter or group of letters taken from a word or words and employed to represent it or them for the sake of brevity. Abbreviations, both of single words and of phrases, having a meaning more or less fixed and recognized, were common in ancient writings and inscriptions *(see* PALAEOGRAPHY). A common form of abbreviation is the substitution for a word of its initial letter. but one or more of the other letters are frequently added. Letters are often doubled to indicate a plural or a superlative. The list below gives a selection of common abbreviations with their meanings. Geographical names (for which *see* the list of abbreviations in vol. 24) are omitted; so are abbreviations for Christian names, weeks and months, points of the compass, and those which have passed into common usage as ordinary words, like Benelux. Cominform and gestapo. For symbols of the chemical elements, *see* ELEMENTS, CHEMICAL; for colloquial expressions (for example, O.K.) *see* AMERICAN ENGLISH and SLANG.

No universally accepted rule as to the use of periods in abbreviations has been followed. The method used in this article is to place periods after the initials of all organizations except U.S. government and United Nations agencies, and some, but not all, organizations whose letters form pronounceable words (called acronyms) such as WAVES. In cases where the abbreviation has multiple meanings, only the most common are given.

COMMON ABBREVIATIONS

A

a.	alto; adjective; answer; *ante;* at
A.	absolute (temperature)
Å	angstrom, angstrom unit, the international wave-length unit
A.A.	Automobile association (Brit.); Alcoholics Anonymous; associate in arts; anti-aircraft
A.A.A.	American Automobile association; Amateur Athletic association (Brit.)
A.A.A.L.	American Academy of Arts and Letters
A.A.A.S.	American Association for the Advancement of Science
A.A.U.	Amateur Athletic union
A.A.U.P.	American Association of University Professors

A.A.U.W.	American Association of University Women
A.B.	able-bodied seaman; bachelor of arts
A.B.A.	American Bar association
abbr., abbrev.	abbreviated; abbreviation
ABC	American Broadcasting company
ab *init.*	(ab initio) from the beginning
abl.	ablative
Abp.	archbishop
A.B.S.	American Bible society
ac.	acre(s)
a/c	account; aircraft
A.C.	(ante Christum) before Christ; alternating current
acc.	accusative
accel.	(accelerando) with increasing speed
A.C.E.	American Council on Education
ac.ft.	acre foot (feet)
A.C.L.S.	American Council of Learned Societies
A.C.L.U.	American Civil Liberties union
A.C.S.	American College of Surgeons; American Chemical society; American Cancer society
ACTH	adrenocorticotropic hormone
A.D.	(anno Domini) in the year of our Lord
A.D.A.	Americans for Democratic Action; American Dental association
adag.	(adagio) slow
ADC	air defense command
A.D.C.	aide-de-camp; Aid to Dependent Children
A.D. and C.	advise duration and charge (telephone, Brit.)
ad fin.	(ad *finem*) at or to the end
ad inf.	(ad infinitum) to infinity
ad *init.*	(*ad initium*) at the beginning
ad int.	(ad interim) in the meantime
adj.	adjective
Adj., Adjt.	Adjutant
ad lib.	(ad libitum) at one's pleasure
ad *loc.*	(ad *locum*) at the place
Adm.	admiral(ty)
adv.	adverb
ad val.	(ad valorem) according to value
A.E. and P.	ambassador extraordinary and plenipotentiary
AEC	Atomic Energy commission (U.S.)
A.E.F.	American or Allied expeditionary force or forces
aet., aetat.	(aetatis) aged
A.F.A.M.	Ancient, Free and Accepted Masons
A.F.C.	air force cross (Brit.)
A.F.L.-C.I.O.	American Federation of Labor-Congress of Industrial Organizations
A.F.M.	air force medal (Brit.)
A.F.S.	Auxiliary Fire service
a.h.	ampere-hour(s)
A.H.	(*anno* Hegirae) in the year of the hegira (Moslem era); (*anno* Hebraico) in the Hebrew year
A.I.A.	American Institute of Architects
A.I.C.	American Institute of Chemists; associate of the Institute of Chemistry (Brit.)
A.I.C.E.	American Institute of Chemical Engineers; associate of the Institution of Civil Engineers (Brit.)
A.I.D.	artificial insemination donor; American Institute of Decorators
A.I.E.E.	American Institute of Electrical Engineers; associate of the Institution of Electrical Engineers (Brit.)
A.I.M. & M.E.	American Institute of Mining and Metallurgical Engineers
A.I.M.E.	associate of the Institution of Mechanical Engineers (Brit.); associate of the Institution of Mining Engineers (Brit.)
A.L.	American Legion
A.L.A.	American Library association
Ald.	alderman
A.L.I.	American Library institute
alt.	altitude; alternate; alto
Am.	American
AM	amplitude modulation
A.M., a.m.	(ante meridiem) before noon; (*anno* mundi) in the year of the world; master of arts
A. & M.	ancient and modern (hymns)
A.M.A.	American Medical association
A.M.D.G.	(Ad *majorem* Dei *gloriam*) to the greater glory of God
A.M.E.	African Methodist Episcopal
Amer.	American
amp.	ampere(s)
amp.hr.	ampere-hour(s)
AMVETS	American Veterans of World War II and Korea
A.N.A.	associate of the National Academy of Design
and.	(andante) moderately slow
Angl.	Anglican
anon.	anonymous
ANPA	American Newspaper Publishers association
ant.	antonym
ant., antiq.	antiquities; antiquarian
ANTA	American National theatre and academy
A.O.H.	Ancient Order of Hibernians
A.O.L.	absent over leave
a.p.	aboveproof (spirits)
A.P.	Associated Press; American Pharmacopeia
A.P.I.	American Petroleum institute
A.P.O.	army post office
A.P.S.	American Philatelic society; American Philosophical society; American Physical society
A.R.A.	associate of the Royal Academy (Brit); American Railway association
A.R.A.M.	associate of the Royal Academy of Music (Brit.)
A.R.C.	American (National) Red Cross
Archd.	archdeacon; archduke
A.R.P.	air raid precautions (Brit.)
art.	article
ARTC	air route traffic control
A.R.V.	American (Standard) Revised version (Bible)
A.S.A.	American Statistical association; Acoustical Society of America
ASCAP	American Society of Composers, Authors and Publishers
A.S.C.E.	American Society of Civil Engineers
A.S.M.E.	American Society of Mechanical Engineers
ASW	antisubmarine warfare
ATC	air traffic control
atm.	atmosphere(s); atmospheric
Atty. Gen.	attorney general
at. wt.	atomic weight
A.U.C.	(*anno urbis conditae* or ab urbe condita) from the founding of the city (Rome)
av.	average; avenue
A.V.	Authorized version (Bible)
A.V.C.	American Veterans committee
avdp.	avoirdupois
ave.	avenue
avoir.	avoirdupois
A.W.O.L.	absent without leave
AWVS	American women's voluntary services

B

b.	born
B.A.	bachelor of arts
B.A.A.S.	British Association for the Advancement of Science
B.A.C.	British Association of Chemists
Bank	International Bank for Reconstruction and Development
Bapt.	Baptist
BAR	Browning automatic rifle
B.Ar., B.Arch.	bachelor of architecture
bart.	baronet
B.B.A.	bachelor of business administration
B.B.B.	Better Business bureau(s)
BBC	British Broadcasting corporation
bbl.	barrel(s)
B.C.	before Christ
B.C.E.	bachelor of civil engineering; bachelor of chemical engineering
BCG	bacillus-Calmette Guérin
B.Ch., B.Chir.	bachelor of surgery
B.C.L.	bachelor of civil law
B.C.P.	Book of Common Prayer
b.d.	brought down (accounting)
B.D.	bachelor of divinity
B.D.A.	British Dental association
bd.ft.	board foot (feet)
b.d.s.	(*bis* in die *sumendus*) to be taken twice a day
Bé.	Baumé (degrees)
B.E.	bachelor of education; Buddhist era
B.E.A.	British Engineers association; British European Airways
B.E.E.	bachelor of electrical engineering
B.E.F.	British expeditionary force
B.E.M.	British empire medal
B. Eng.	bachelor of engineering
BES	bureau of employment security
Bev	billion electron volts
bf, b.f.	boldface (typography); brought forward
b.h.p.	brake horsepower
Bib., bibl.	Bible, biblical
bibliog.	bibliography; bibliographer
B.I.S.	Bank for International Settlements
Bl.	(the) Blessed (title)
B.L.	British Legion
B.Lit(t).	bachelor of literature (or of letters)
B.LL.	bachelor of laws
BLS	bureau of labour statistics
blvd.	boulevard
b.m.	board measure; bench mark
B.M.	bachelor of medicine; beachmaster; British Museum
B.M.A.	British Medical association
B.M.E.	bachelor of mechanical engineering; bachelor of mining engineering
B.M.I.	Broadcast Music, Inc.
B. Mus.	bachelor of music
B.O.A.C.	British Overseas Airways corporation
B.O.Q.	bachelor officers' quarters
bor.	borough
B.O.T.	board of trade
boul.	boulevard
b.p.	boiling point; below proof (spirits)
Bp.	bishop
B.P.	British Pharmacopoeia
B.Phil.	bachelor of philosophy
B.P.O.E.	Benevolent and Protective Order of Elks
B.R.C.S.	British Red Cross society
Brig.	brigadier; brigade
Brig. Gen.	brigadier general
Brit.	British; Britannica
bros.	brothers
B.S., B.Sc.	bachelor of science or sciences
B.S.A.	Boy Scouts of America

B.S.T.	British summer time
bt.	baronet
B.T.	board of trade
B.Th.	bachelor of theology
B.Th.U.	British thermal unit(s)
B.T.U.	board of trade unit(s) (Brit.); British thermal unit(s)
bu.	bushel(s)
B.V.M.	the Blessed Virgin Mary
bx.	box(es)

C

c.	(circa) about
c., ¢	cents
C	(caput) chapter
C.	centigrade
C.A.	chartered accountant; Catholic Action
CAB	Civil Aeronautics board
cal.	calorie(s); calibre
Cantab.	(Cantabrigiensis) of Cambridge (university)
cap.	(caput) chapter
cap., caps.	capital(s)
CAP	civil air patrol
Capt.	captain
car.	carat(s)
Card.	cardinal
CARE	Cooperative for American Remittances to Everywhere
Cath.	Catholic
C.B.	companion of the order of the Bath (Brit.)
CBC	Canadian Broadcasting corporation
C.B.E.	commander order of the British empire
C.B.I.	Cumulative Book Index
CBR	chemical, biological, radiological (warfare)
CBS	Columbia Broadcasting system
CC	cubic centimetre(s)
CCC	Commodity Credit corporation
C.D.	Corps diplomatique
Cdr.	commander
C.E.	civil engineer; Christian Endeavor; chemical engineer
C.E.F.	Canadian expeditionary force
cent.	(centum) a hundred; centigrade
cet. par	(*ceteris paribus*) other things being equal
c. ft.	cubic foot (feet)
cf.	(confer) compare
cg.	centigram(s)
c.g.	centre of gravity; consul general
C.G.	coast guard; commanding general
C.G.I.A.	City and Guilds of London Institute insignia award
C.G.M.	conspicuous gallantry medal (Brit.)
C.G.S., c.g.s.	centimetre-gram-second (s)
C.G.T.	(Confederation Générale du Travail) General Confederation of Labour (Fr.)
ch.	chapter
c.h.	central heating
C.H.	companion of honour (Brit.)
chap.	chapter
Chem.E.	chemical engineer
CIA	central intelligence agency
CIC	combat information centre
C.I.D.	criminal investigation department (Brit.)
C.I.E.	companion of the order of the Indian empire (Brit.)
cie.	(*compagnie*) company (Fr.)
C.I.F.	cost, insurance, freight
C.I.G.S.	chief of the imperial general staff (Brit.)
CINC, C. in C.	commander in chief
cl	centilitre(s)
cm.	centimetre(s)
C.M.G.	companion of the order of St. Michael and St. George (Brit.)
C.M.H.	(congressional) medal of honor
co.	company; county
c.o., c/o	care of; carried over
C.O.	commanding officer; conscientious objector
C.O.D.	collect or cash on delivery
co-ed.	co-educational
C. of E.	Church of England
col.	column
Col.	colonel
Comdr.	commander
Comdt.	commandant
Comm.	commander
comp.	compiled; compiler
con.	consolidated; consul; concerto; (contra) against
Conelrad	control of electromagnetic radiation
Cong.	congregation; Congregational; congress
cont.	contents; continue(d); continent; (contra) against
conv.	convent; convention; conversation; converter
co-op.	co-operative
corp.	corporation; corporal
cos	cosine
cot	cotangent
c.p.	candle power; chemically pure; common pleas; court of probate; centre of pressure
C.P.	Communist party
C.P.A	certified public accountant; chartered public accountant
Cpl.	corporal
C.P.O.	chief petty officer
c.p.s., cps	cycles per second
C.R.	(*Custos* Rotulorum) keeper of the rolls
cres., cresc.	(crescendo) with gradually increasing volume
C.S.A.	Confederate States of America
csc	cosecant
CSC	Civil Service commission
C.S.I.	companion of the order of the Star of India; Church of South India
C.S.O.	chief signal officer; chief staff officer
C.S.P.	Congregation of Saint Paul
C.S.T.	central standard time
ct.	cents; count
ctn	cotangent
cu.	cubic; cumulus
cu.cm.	cubic centimetre(s)
cu.ft.	cubic foot (feet)
cu.in.	cubic inch(es)
C.V.O.	commander of the Royal Victorian order
CW	continuous wave (radio)
C.W.S.	Co-operative Wholesale society (Brit.)
cwt.	hundredweight(s)
C.Y.o.	Catholic Youth organization

D

d.	deceased; died; daughter
d.	(denarius) penny
da.	daughter
D.A.	district attorney
D.A.B.	Dictionary of American Biography
D.A.E.	Dictzonary *of* American English
D.A.R.	Daughters of the American Revolution
dat.	dative
D.A.V.	Disabled American Veterans
db	decibel
D.B.E.	dame commander of the. order of the British empire
D.C.	(da capo) from the beginning; direct current
dcg.	decagram(s)
dcl.	decalitre(s)
D.C.L.	doctor of civil law
dcm.	decametre(s)
D.C.M.	distinguished conduct medal (Brit.)
D.C.V.O.	dame commander of the Royal Victorian order
D.D.	doctor of divinity
D.D.M.	doctor of dental medicine
D.D.S.	doctor of dental surgery
DDT	dichloro-diphenyl-trichloroethane
dec.	deceased
decim.	decimetre(s)
decresc.	(decrescendo) with gradually decreasing volume
del.	(delineavit) he (or she) drew (it)
dele.	(*deleatur*) delete
Dem.	Democrat; Democratic
D.Eng.	doctor of engineering
dept.	department
DEW	Distant Early Warning radar line
DF, D/F	direction finding or finder
D.F.C.	distinguished flying cross (Brit.)
dg.	decigram(s)
D.G.	(Dei gratia) by the grace of God
diam.	diameter
dim.	(diminuendo) with gradually diminishing volume
D.J.S.	doctor of juridical science
dl.	decilitre(s)
D.Lit(t).	doctor of literature (or of letters)
dm	decimetre(s)
D.M.D.	doctor of dental medicine
DME	distance measuring equipment
D.M.S.	doctor of medical sciences
D.Mus.	doctor of music
D.N.B.	Dictionary of National Biography (Brit.)
do.	(ditto) the same
doz.	dozen
DP	displaced person
D.Phil.	doctor of philosophy
dr.	drachma(s) or dram(s); debtor
d.r.	dead reckoning
Dr.	doctor
D.Sc.	doctor of science
D.S.C.	distinguished service cross
D.S.M.	distinguished service medal
D.S.O.	companion of the distinguished service order
D.S.T.	daylight saving time; doctor of sacred theology
d.t.	delirium tremens
D.T.	doctor of theology
duo.	duodecimo
D.V.	(Deo *volente*) God willing; Douay version (Bible)
D.V.M.	doctor of veterinary medicine
D.V.S.	doctor of veterinary surgery
dwt.	pennyweight(s)

E

e.	eldest
ea.	each
ed.	editor; edited; edition; educated
eds.	editors
e.e.	errors excepted
E.E.	Early English; electrical engineer
E.E. & M.P.	envoy extraordinary and minister plenipotentiary
e.g.	(exempli gratia) for example
e.h.p.	effective horsepower
E.M.	earl marshal; enlisted man
emf	electromotive force
E.M.U.	electromagnetic unit
ency., encyc.	encyclopaedia
Eng.	English
Ens.	ensign (flag); ensign (title)
Epis., Episc.	Episcopal
ESC	Economic and Social council
esp., espec.	especially
ESP	extrasensory perception

Esq.	esquire
est.	established; estimated; estuary
E.S.T.	eastern standard time
E.S.U.	electrostatic unit(s)
e.t.a.	estimated time of arrival
et al.	(*et alii* or *aliae*) and others; (*et alibi*) and elsewhere
etc.	(et cetera) and so forth
et seq.	(*et sequens, sequentes* or *sequentia*) and the following
etym.	etymological; etymology
Euratom	European Atomic Energy community
ev	electron volt(s)
ex lib.	(*ex libris*) from the books of
ext.	extension; external(ly); extinct; extant

F

f.	farad(s); father; folio; following; feminine
f.	(forte) loud, powerful
F.	Fahrenheit
FAA	Federal Aviation agency
FAO	Food and Agriculture organization
F.B.A.	fellow of the British academy
FBI	Federal Bureau of Investigation
FCA	Farm Credit administration
FCC	Federal Communications commission
FCIC	Federal Crop Insurance corporation
F.C.S.	fellow of the Chemical society (Brit.)
F.D.	(*Fidei Defensor*) Defender of the Faith (Brit.); fire department
FDA	Food and Drug administration
FDIC	Federal Deposit Insurance corporation
fec.	(*fecit*) he (or she) made (or did) (it)
fem.	feminine
FEPC	Committee on Fair Employment Practice
ff.	following (pages); folios
ff.	(fortissimo) very loud
F.F.P.S.	fellow of the Royal Faculty of Physicians and Surgeons (Glasgow)
F.G.S.	fellow of the Geological society (Brit.)
FHA	Federal Housing administration
fig.	figure(s)
fl.	flourished
fl.oz.	fluid ounce(s)
F.L.S.	fellow of the Linnean society
fm.	fathom(s)
FM	frequency modulation
F.M.	field marshal
F.O.	foreign office (Brit.); flying officer
f.o.b.	free on board
F.O.E.	Fraternal Order of Eagles
fol.	folio; following
f.p.	foot-pound(s); freezing point
FPC	Federal Power commission
F.Phys.S.	fellow of the Physical society (Brit.)
f.p.s.	foot-pound-second; feet per second
F.P.S.	fellow of the Philological society (Brit.); fellow of the Philosophical society (Brit.)
fr.	franc(s); from; father
Fr.	Father (title); friar; French
F.R.A.I.	fellow of the Royal Anthropological institute (of Great Britain and Ireland)
F.R.A.S.	fellow of the Royal Astronomical society (Brit.)
F.R.C.M.	fellow of the Royal College of Music
F.R.C.P.	fellow of the Royal College of Physicians, London
F.R.C.P.E.	fellow of the Royal College of Physicians of Edinburgh
F.R.C.S.	fellow of the Royal College of Surgeons, London
F.R.C.V.S.	fellow of the Royal College of Veterinary Surgeons (Brit.)
F.R.G.S.	fellow of the Royal Geographical society, London
F.R.Hist.S.	fellow of the Royal Historical society, London
F.R.H.S.	fellow of the Royal Horticultural society, London
F.R.I.B.A.	fellow of the Royal Institute of British Architects
F.R.Met.S.	fellow of the Royal Meteorological society
F.R.S.	fellow of the Royal society (of London)
F.R.S.E.	fellow of the Royal Society of Edinburgh
F.R.S.L.	fellow of the Royal Society of Literature (of the United Kingdom)
F.S.A.	fellow of the Society of Antiquaries (of London)
F.S.C.	(*Fratrem Scholarum Christianorum*) Brothers of the Christian Schools (Christian Brothers)
F.S.S.	fellow of the Royal Statistical society (of London)
ft.	foot; feet
Ft.	fort
FTC	Federal Trade commission
Fund	International Monetary fund
fur.	furlong(s)
f.v.	(*folio verso*) on the back of the page
fwd.	forward
F.Z.S.	fellow of the Zoological society, London

G

g.	gram(s); acceleration of gravity; good; guinea(s)
gal.	gallon(s)
G.A.O.	general accounting office
G.A.R.	Grand Army of the Republic
G.A.T.T.	General Agreement on Tariffs and Trade
gaz.	gazette; gazetteer
G.B.E.	knight or dame grand cross of the order of the British empire
G.C.	George cross
GCA	ground-controlled approach
g.cal.	gram calorie(s)
G.C.B.	knight grand cross of the order of the Bath
G.C.E.	General Certificate of Education (Brit.)
GCI	ground-controlled interception
G.C.I.E.	knight grand commander of the order of the Indian empire
G.C.M.G.	knight grand cross of the order of St. Michael and St. George
G.C.S.I.	knight grand commander of the order of the Star of India
G.C.T.	Greenwich civil time
G.C.V.O.	knight grand cross of the Royal Victorian order
g.d.	granddaughter
gen.	genitive; general; genus
Gen.	general (title)
GG	gamma globulin
G.H.Q.	general headquarters
gi.	gill(s)
G.M.	general manager; George medal
gm.	gram(s)
G.M.T.	Greenwich mean time
G.O.E.	General Ordination Examination
G.O.P.	grand old party (Republican)
Gov.	governor
g.p.	general practitioner
g.p.m.	gallons per minute
GPO	government printing office
G.P.O.	general post office
gr.	grain(s); gross
g.s.	grandson
GSA	General Services administration
G.S.A.	Girl Scouts of America

H

h.	husband
H	henry (elect.)
ha.	hectare(s)
h. & c.	hot and cold
h.c.f.	highest common factor
H.E.	his, or her, excellency; high explosive
Heb., Hebr.	Hebrew(s)
her.	heraldic; heraldry
HF	high frequency
H.G.	his, or her, grace
hg.	hectogram(s)
H.H.	his, or her, highness; his holiness (the pope)
hhd.	hogshead(s)
hi-fi	high fidelity
H.I.H.	his, or her, imperial highness
H.I.M.	his, or her, imperial majesty
H.J.S.	(*hic jacet sepultus*) here lies buried
hl.	hectolitre(s)
hm.	hectometre(s)
H.M.	his, or her, majesty('s)
H.M.S.	his, or her, majesty's ship, or service
H.M.S.O.	his, or her, majesty's stationery office
Hon.	honourable; honorary
h.p.	horsepower; high pressure; hire purchase
H.Q., hq.	headquarters
hr.	hour(s)
H.R.	house of representatives; house of representatives bill
H.R.H.	his, or her, royal highness
H.S.H.	his, or her, serene highness

I

I.	island
ib., ibid.	(*ibidem*) in the same place
I.C.A.A.A.A.	Intercollegiate Association of Amateur Athletics in America
ICAO	International Civil Aviation organization
ICBM	intercontinental ballistic missile
ICC	Interstate Commerce commission
I.C. 4-A	Intercollegiate Association of Amateur Athletics in America
id.	(*idem*) the same
i.e.	(*id est*) that is
IFC	International Finance corporation
IFR	instrument flight rules
I.G.	inspector general
IGY	International Geophysical year
i.h.p.	indicated horsepower
IHS	a symbol representing IHΣ, the first three letters of the Greek name of Jesus; also *Iesus Hominum Salvator* (Jesus the Saviour of Men)
I.L.G.W.U.	International Ladies' Garment Workers' union
ILO	International Labour organization
ILS	instrument landing system
IMCO	Inter-Governmental Maritime Consultative organization
imp.	imperative; imperfect (tense); imperial; (*imprimatur*) let it be printed
in.	inch(es)
Inc.	incorporated
incl.	inclosure; inclusive; including
incog.	(incognito) unknown
inf.	(infra) below
infra dig	(infra dignitatem) undignified
in loc. cit.	(*in loco citato*) in the place cited
I.N.R.I.	(*Iesus Nazarenus Rex Iudaeorum*) Jesus of Nazareth, King of the Jews

inst.	instant, the present month
int.	interest
int. *al.*	(inter alia) among other things
I.O.F.	Independent Order of Foresters
I.O.O.F.	Independent Order of Odd Fellows
I.O.U.	I owe you
I.P.A.	International Phonetic association or alphabet
i.q.	(*idem* quod) the same as
I.Q.	intelligence quotient
I.R.A.	Irish Republican army
IRBM	intermediate-range ballistic missile
IRO	International Refugee organization
IRS	internal revenue service
Is.	island(s)
I.S.O.	imperial service order
ital.	italics
I.T.A.	Independent Television authority (Brit.)
ITO	International Trade organization
ITU	International Telecommunications union
I.V.	initial velocity
I.W.W	Industrial Workers of the World

J

J.A.	Junior Achievement (U.S.)
J.A.G.	judge advocate general
jato	jet-assisted take-off
J.C.D.	(*juris civilis* doctor) doctor of civil law
J.D.	(*jurum* doctor) doctor of laws
j.g.	junior grade (U.S. navy)
J.M.J.	Jesus, Mary and Joseph
jnr.	junior
jp	jet propulsion
J.P.	justice of the peace junior

K

k.	carat(s); knot(s)
K.	Kelvin
K.B.E.	knight commander of the order of the British empire
kc.	kilocycle(s)
K.C.	king's counsel; Knights of Columbus
K.C.B	knight commander of the order of the Bath
K.C.I.E.	knight commander of the order of the Indian empire
K.C.M.G.	knight commander of the order oi St. Michael and St. George
K.C.S.I.	knight commander of the order of the Star of India
K.C.V.O.	knight commander of the Royal Victorian order
kg.	kilogram(s)
K.G.	knight of the order of the Garter
kg.cal.	kilogram calorie(s); kilocalorie(s)
K.K.K.	Ku Klux Klan
kilo(s)	kilogram(s)
kl.	kilolitre(s)
K.L.M.	Koninklijke Luchtvaart Maatschappij voor Nederland en Kolonien N.V. (Royal Dutch Airlines)
km.	kilometre(s)
k.o.	knockout (pugilism)
K.P.	knights of Pythias; knight of the order of St. Patrick (Brit.); kitchen police (military)
kt.	carat(s); kiloton; knot(s)
Kt.	knight
K.T.	Knight(s) Templar; knight of the order of the Thistle (Scot)
kv.	kilovolt(s)
kva.	kilovolt ampere(s)
km.	kilowatt(s)
kw.hr.	kilowatt hour(s)

L

l.	litre(s); length; line(s)
L.. £	(*libra*) pound(s) (money)
L.	(liber) book
lat.	latitude
lb.	(*libra*) pound(s) (weight)
l.b.w.	leg before wicket (cricket)
l.c.	lower case (typography); letter of credit; level crossing
L.C.	Library of Congress; lord chamberlain; lord chancellor
L.C.C.	London County council
l.c.d.	lowest common denominator
L.C.J.	lord chief justice
L.C.M.	least common multiple
LF	low frequency
L.H.D.	doctor of humanities
lib.	library; librarian
lib.	(liber) book
Lieut.	lieutenant
Linn.	Linnaeus; Linnaean
Lit(t).D.	doctor of literature (or of letters)
ll.	lines
L.L., L.Lat.	Law Latin
LL.B.	(legum baccalaureus) bachelor of laws
LL.D.	(*legum* doctor) doctor of laws
LL.M.	(legum magister) master of laws
loc.cit.	(loco citato) in the place cited
log	logarithm
long.	lonnitude
L.O.O.M.	Loyal Order of Moose
loq.	(*loquitur*) he (or she) speaks
LOX	liquid oxygen explosive
LP	long playing (phonograph records); liquefied petroleum
L.R.A.M.	licentiate of the Royal Academy of Music (Brit.)
L.R.C.P.	licentiate oi the Royal College of Physicians (Brit.)
L.R.C.P.E.	licentiate of the Royal College of Physicians, Edinburgh
L.R.C.S.	licentiate of the Royal College of Surgeons (Brit.)
l.s.	(locus sigilli) place of the seal
Lt.	lieutenant
l.t.	long ton(s)
Ltd.	limited
Luth.	Lutheran

M

m.	married; metre(s); minim; masculine
M.	(*meridies*) meridian, noon; mark(s); (*mille*) thousand(s); monsieur
M.A.	(magister *artium*) master of arts
Maj.	major
M. & B.	May and Baker 693 (drug)
Marq.	marquis
masc.	masculine
MATS	military air transport service
max.	maximum
M.B.	(medicinae baccalaureus) bachelor of medicine
M.B.A.	naster of business administration
M.B.E.	member of the order of the British empire
MBS	Mutual Broadcasting system
mc.	megacycle(s)
MC	millicurie; medical corps
M.C.	master of ceremonies; member of congress; military cross (Brit.)
M.D.	(*medicinae* doctor) doctor of medicine
M.E.	Middle English; Methodist Episcopal; mechanical engineer; mining engineer
mem.	(memento) memorandum
m.e.p.	mean effective pressure
Messrs.	messieurs; sirs
Meth.	Methodist; methylated spirits
Mev	million electron volts
mf.	(mezzo forte) moderately loud
M.F.H.	master of foxhounds
mg.	milligram(s)
Mgr.	monsignor; monseigneur; manager
m.g.s.	metre-gram-second(s)
mh	millihenry
mi.	mile(s)
M.I.E.E.	member of the Institution of Electrical Engineers (Brit.)
M.I.Mech. E.	member of the Institution oi Mechanical Engineers (Brit.)
M.I.Min.E.	member of the Institution of Mining Engineers (Brit.)
min.	minute(s)
misc.	miscellaneous; miscellany
M.Lit(t).	master of literature (or of letters)
ml.	millilitre(s)
Mlle.	mademoiselle
MM.	messieurs; sirs
mm.	millimetre(s)
mμ	millimicron(s)
Mme(s)	madame; mesdames
M.M.F.	magnetomotive force
mo.	month(s)
M.O.	medical officer; money order
mod.	(moderato) moderately fast; modern
mol.	molecule(s); molecular
mol.wt.	molecular weight
mp.	(mezzo piano) moderately soft
m.p.	melting point
M.P.	member of parliament; military police; Methodist Protestant
m.p.g.	miles per gallon
m.p.h.	miles per hour
Mr.	mister
M.R.C.P.	member of the Royal College of Physicians (London)
M.R.C.S.	member of the Royal College of Surgeons (Brit.)
M.R.C.V.S.	member of the Royal College of Veterinary Surgeons (Brit.)
M.R.P.	(*Mouvement Républicain Populaire*) Republican Popular movement (France)
Mrs.	mistress
ms.	manuscript
M.S., M.Sc.	master of science
Msgr.	monsignor
m.s.l.	mean sea level
mss.	manuscripts
M.S.T.	mountain standard time
m.t.	metric ton
Mt., mt., mts.	mount, mountain; mountains
mth.	month
μ	micron(s); micro-
μv	microvolt(s)
μsec.	microsecond(s)
mun.	municipal
Mus.B., D., M.	(musicae *baccalaureus,* doctor, magister) bachelor, doctor, master of music
mv	millivolt(s)
MVD	(Ministerstvo *Vnutrennikh* Del) ministry of internal affairs, including secret police (U.S.S.R.)
M.V.O.	member of the Royal Victorian order
myth.	mythology; mythological

N

n.	noun; name; normal; neuter; note
N.A.	National Academician or Academy
N.A.A.C.P.	National Association for the Advancement of Colored People
N.A.D.	National Academy of Design
N.A.M.	National Association of Manufacturers
N.A.S.	National Academy of Sciences
NASA	National Aeronautics and Space administration
NATO	North Atlantic Treaty organization

n.b.	(nota bene) note well
NBC	National Broadcasting company
N.C.A.A.	National Collegiate Athletic association
N.C.O.	noncommissioned officer
N.C.W.C.	National Catholic Welfare conference
N.C.Y.C.	National Catholic Youth council
n.d.	no date
n.e.	new edition
N.E.A.	Newspaper Enterprise association; National Education association
nem.con.	(nenzine contradicente) no one contradicting; unanimous
neut.	neuter; neutral
New Test.	New Testament
N.F.S.	National Fire service (Brit.)
N.G.	national guard; no good
NLRB	National Labor Relations board
nn.	notes
no.	(numero) number(s)
nol. pros.	(nolle prosequi) unwilling to prosecute
nom.	nominative; nominated; nominal; nomenclature
non.seq.	(non sequitur) it does not follow
Nor., Norm.	Norman
NORAD	North American Air Defense Command
N.P.	notary public
n.p.t.	normal (blood) pressure and temperature
nr.	near
NRC	National Research council
NS	nuclear (powered) ship
N.S.	new style (calendar); new series
N.S.P.C.C.	National Society for the Prevention of Cruelty to Children
N.T.	New Testament

O

o	ohm
OASI	old-age and survivors insurance (social security, U.S.)
ob.	(*obiit*) he (or she) died
obdt.	obedient
O.B.E.	order of the British empire
OCD	Office of Civilian Defense
OCDM	Office of Civil. and Defense Mobilization
O.C.S.	officer candidate school
o.d.	overdraft
O.D.	officer of the day; olive drab; ordinary seaman
O.E.	Old English
O.E.D.	Oxford *English* Dictionary
O.E.E.C.	Organization for European Economic Co-operation
O.E.S.	Order of the Eastern Star (U.S.)
O.F.	Old French
off.	official; office; officer; offered
O.F.M.	(*Ordo Fratrum Minorum*) Order of Friars Minor (Franciscans)
O.H.M.S.	on his, or her, majesty's service
O.M.	order of merit (Brit.)
O.O.D.	officer of the deck
op.	opus; opera; opposite
O.P.	Order of Preachers (Dominicans); observation post
op.cit.	(*opere* citato) in the work cited
ord.	ordained; ordinance; ordnance
O.S.	old style (calendar); outsize
O.S.A.	Order of St. Augustine
O.S.B.	Order of St. Benedict
O.S.F.	Order of St. Francis
OSRD	Office of Scientific Research and Development
O.T.	Old Testament
Oxf.	Oxford
Oxon.	(Oxonia, Oxoniensis) Oxford; of Oxford (university)
oz.	(onza) ounce(s)

P

P.	parking
p.	page
p.	(piano) soft
par.	parallel; parenthesis; parish; parochial; paragraph
para.	paragraph
parl.	parliament; parliamentary
P.A.S.I.	professional associate of the Chartered Surveyors' institution (Brit.)
pat., patd.	patent; patented
Pat. Off.	patent office
P.A.U.	Pan American union
P.C.	privy council(or); police constable
pd.	paid
P.D.	police department
P.E.	Protestant Episcopal
P.E.N.	International Association of Poets, Playwrights, Editors, Essayists and Novelists
pert.	pertaining
p.f.	(*più* forte) a little louder
Pfc.	private first class
P.G.A.	Professional Golfers association
pH	logarithm of the reciprocal of hydrogen-ion concentration
PHA	Public Housing administration
phar.	pharmacy; pharmaceutical
Ph.B.	bachelor of philosophy
Ph.C.	pharmaceutical chemist
Ph.D.	doctor of philosophy
PHS	public health service
pinx.	(pinxit) he (or she) painted (it)
pizz.	(pizzicato) plucked (music)
pl.	plural; place; plate
P.M., p.m.	past master; postmaster; (post meridiem) afternoon; provost marshal; prime minister; post mortem
p.o.	post office; postal order; petty officer (naval)
POD	post office department
P.O.E.	port of embarkation
POP.	population
POW	prisoner of war
pp.	pages
pp.	(pianissimo) very soft
P.P., p.p.	parcel post; parish priest; present participle; past participle; postpaid; per pro.
P.P.S.	(post postscviptum) an additional postscript
P.R.	proportional representation; public relations
prep.	preposition; preparatory; preparation
Pres.	president; present; presumptive
Presb.	Presbyterian
P.R.O.	public record office; public relations officer
proc.	proceedings
Prof.	professor
pron.	pronoun; pronunciation
prop.	proprietor; proposition; property
propr.	proprietor
pro tem	(pro tempore) for the time being
prov.	provisional; provost; province
prox.	(proximo [mense]) next month
P.S.	(postscriptum) postscript
pseud.	pseudonym
P.S.T.	Pacific standard time
PT	physical training
pt.	part; pint(s); point; port
p.t.	(pro tempore) for the time being
P.T.A.	Parent-Teacher association
PTM	phase time modulation
P.T.O.	please turn over
pub., publ.	publication; published; public
Pvt.	private
PWA	Public Works administration
pwt.	pennyweight
PX	post exchange
pxt.	(pinxit) he (or she) painted (it)

Q

q.	quintal; query; question
Q.C.	queen's counsel
Q.E.D.	(quod erat *demonstrandum*) which was to be demonstrated
Q.E.F.	(quod erat faciendum) which was to be done
q.l.	(*quantum* libet) as much as you please
Q.M.	quartermaster
qq.v.	(*quae* vide) which see (plural)
qr.	quarter; quarterly; quire
q.s.	(quantum suficit) as much as is sufficient
qt.	quart(s)
qu.	query; question
quant. *suff.*	(quantum suficit) as much as is sufficient
q.v.	(quod vide) which see; (quantum ***vis)*** as much as you will
qy.	query

R

R.	(vex, regina) king, queen; river
R., ℞	(recipe) take
R.A.	Royal Academy (of Arts, London)
R.A.A.F.	Royal Australian air force
rabb.	rabbinical
R.A.C.	Royal Automobile club
rad.	(radix) root; radical
R.A.D.A.	Royal Academy of Dramatic Art (Brit.)
RADM	rear admiral (U.S. navy)
R.A.F.	Royal Air Force
rall.	(rallentando) gradually slower
R.A.M.	Royal Academy of Music (Brit.)
R.A.N.	Royal Australian navy
R. & I.	(rex et imperator) king and emperor
R.B.A.	Royal Society of British Artists
R.C.	Roman Catholic; Red Cross
R.C.A.F.	Royal Canadian air force
R.C.M.P.	Royal Canadian mounted police
R.C.N.	Royal Canadian navy
R.C.P.	Royal College of Physicians or Preceptors
R.C.S.	Royal College of Surgeons
rd.	road
Réaum.	Réaumur's thermometrical scale
REA	Rural Electrification administration
Rear Adm.	rear admiral
Reg. Prof.	regius professor
rel.	religion; relative
R.E.M.E.	royal electrical and mechanical engineers
Rep.	Republican; representative
ret.	retired; returned
Rev.	reverend
RFC	Reconstruction Finance corporation
R.F.D.	rural free delivery
Rh	Rhesus factor
R.H.S.	Royal Historical society
R.I.B.A.	Royal Institute of British Architkcts
R.I.P.	(requiescat in pace) may he (or she) rest in peace
rit.	(ritardando) gradually slower
riv.	river
rm.	room(s)
R.M.	royal marines; resident magistrate; royal mail
R.M.A.	Royal Military academy (Sandhurst)
R.M.O.	resident medical officer(s)
R.M.S.	royal mail steamer (Brit.)
R.N.	Royal Navy; registered nurse
R.N.V.R.	royal naval volunteer reserve
R.N.Z.N.	Royal New Zealand navy
Rom.	Roman; romance
R.O.T.C.	reserve officers' training corps
r.p.m.	revolutions per minute
r.p.s.	revolutions per second
rot.	reocat; report
R.R.	railroad
R.S.M.	regimental sergeant major, Royal Society of Medicine

R.S.P.C.A. Royal Society for the Prevention of Cruelty to Animals
R.S.V. Revised Standard version (Bible)
R.S.V.P. (*répondez* s'il vous *plaît*) please reply
Rt. Hon. right honourable
Rt. Rev. right reverend
R.V. Revised version (Bible)
Ry. railway
R.Y.S. royal yacht squadron

S

s. son; second(s); series
s. (solidus) shilling
s. san (saint); senate bill
S.A. Salvation Army
SAC strategic air command
S.A.E. Society of Automotive Engineers
Sans., Sansk. Sanskrit
S.A.R. Sons of the American Revolution
sb. substantive
sc. scruple; science
sc. (scilicet) namely; (sculpsit) he (or she) carved or engraved (it)
s.c. small capital letters
SC Security council (of United Nations)
Sc.D. (scientiae doctor) doctor of science
scr. scruple
SCUBA self-contained underwater breathing apparatus
sculp., *sculpt.* (sculpsit) he (or she) carved or engraved (it)
sd. said; signed
s.d. (sine die) without (appointing) a day (on which to assemble again)
SEATO Southeast Asia Treaty organization
sec secant
sec. section; second(s); secretary
SEC Securities and Exchange commission
Sen. senator; senate; senior
seq., seqq. (sequens, sequentia) the following
sergt. sergeant
sf. (sforzando) with emphasis
Sgt. sergeant
SHAPE supreme headquarters Allied powers Europe
sin sine
sing. singular
S.J. Society of Jesus (Jesuits)
SOP standing operating procedure
sost. (sostenuto) sustained
sp. spelling; species; specific; spirit
s.p. (sine prole) without offspring
S.P. shore patrol
SPAR women's reserve of the United States coast guard (contraction of coast guard motto, semper *paratus* [always prepared])
S.P.G.A. Society for Prevention of Cruelty to Animals
S.P.C.C. Society for Prevention of Cruelty to Children
S.P.C.K. Society for Promoting Christian Knowledge (Brit.)
S.P.G. Society for the Propagation of the Gospel (Brit.)
sp. gr. specific gravity
sp. ht. specific heat
S.P.Q.R. (*senatus populusque Romanus*) senate and people of Rome
sq. squadron; square
sq. (*sequens, sequentia*) the following
sq.ft. square foot (feet)
Sr. senior; seiior
Sra. señora
S.R.N. state registered nurse (Brit.)
S.R.O. standing room only
Srta. seiiorita
ss. (scilicet) namely
SS. saints
S.S. steamship
S.S.R.C. Social Science Research council
st. stanza; stone (weight)
s.t. short ton(s)
St. saint; strait; statute(s); street
Sta. (*santa*) saint; station
stacc. (staccato) distinct; separated
stat. statics; (statim) immediately; statistics
Ste. (*sainte*) saint
S.T.P. professor of sacred theology
sub. subaltern; substitute(s); subeditor; submarine; subscription; subject; subjunctive
subj. subject; subjunctive
sup. (supra) above
supp., suppl. supplement
s.v. (sub verbo, sub *voce*) under the word (or heading)
syn. synonym; synonymous

T

t. ton(s); town; transitive
T.A. territorial army (Brit.)
TAC tactical air command
tan tangent
TASS (Telegraphnoye Agenstvo *Sovyetskovo* Soyuza) Soviet news agency
t.b. tuberculosis, tubercle bacillus
TBS talk between ships (radio)
tbs., tbsp. tablespoon(s)
t.d.s. (ter *in* die sumendus) to be taken three times a day
T.E. topographical engineer
terr. territory; terrace
t.i.d. (ter in die) three times daily (pharm.)
t.k.o. technical knockout (pugilism)
t.l. trade last
TNT trinitrotoluene (explosive)
tr. translated; translator; transpose; transitive
trans. transferred; translation
trem. (tremolo) trembling; fluttering
tsp. teaspoon
TT. teetotaler; tourist trophy
T.U.C. Trades Union congress (Brit.)
TV television; test vehicle (guided missiles)
TVA Tennessee Valley authority
twp. township

U

UCMJ Uniform Code of Military Justice (U.S.)
U.C.V. United Confederate Veterans
U.D.C. United Daughters of the Confederacy; urban district council (Brit.)
UES electrostatic unit(s)
UFO unidentified flying object
UHF ultrahigh frequency
ult. (ultimo) last (month)
UN United Nations
UNAC United Nations Appeal for Children
UNEF United Nations Emergency force
UNESCO United Nations Educational, Scientific and Cultural organization
UNICEF United Nations Children's fund
univ. university; universal
U.P.I. United Press International
UPU Universal Postal union
U.S. unscrviccable
u.s. (*ubi* supra) in the place above mentioned
USA United States army
USAF United States air force
USCG United States coast guard
USES United States employment service
USGS United States geological survey
USIA U.S. Information agency
U.S.M. United States mail
U.S.M.A. United States Military academy
USMC United States marine corps.
USN United States navy
U.S.N.A. United States Naval academy
USNR United States naval reserve
U.S.O. United Service organizations
U.S.P. United States Pharmacopoeia
USPHS U.S. public health service
U.S.S. United States ship; United States senate
U.S.S.S. United States secret service

V

v. volt(s); verb; very; verse; village
v. (vide) see
v. (versus) against; verse
VA Veterans administration
V.A.D. voluntary aid detachment
V.C. vice-chancellor; Victoria cross
V.D. venereal disease
Ven. venerable
vet. veterinary; veteran
VFR visual flight rules
V.F.W. Veterans of Foreign Wars
VHF very high frequency
vic. vicar; vicarage
vid. (vide) see
Vis., Visc., Visct, viscount
viz. (videlicet) namely
v.l. (varia Zectio) varient reading(s)
voc. vocative
vol. volume(s); volunteers; volcano
vox pop. (vox populi) voice of the people
V.P. vice-president
vs. verse
v.s. (vide supra) see above
VTO vertical take-off
Vul., Vulg. Vulgate (Bible)

W

w. watt(s); wife
WAC women's army corps; World Aeronautic chart
WAF women's air force
WAVES women accepted for volunteer emergency service (United States naval reserve)
W.C.C. World Council of Churches
W.C.T.U. Woman's Christian Temperance union
WHO World Health organization
W.I. Women's institute
w.l. wave length
WMO World Meteorological organization
WPA Works Projects administration
W.R.A.C. women's royal army corps
W.R.A.F. women's royal air force
WREKS, W.R.N.S. women's royal naval service
W.S. women's size
WSB Wage Stabilization board
wt. weight; without
W.V.S. women's voluntary services
W.X. women's extra (outsize)

X

X Christ; Christian
XQ cross question

Y

y. youngest
yd. yard(s)
Y.M.C.A. Young Men's Christian association
Y.M.-Cath.A. Young Men's Catholic association
Y.M.H.A. Young Men's Hebrew association
yr. year(s); younger; your
Y.W.C.A. Young Women's Christian association
Y.W.H.A. Young Women's Hebrew association

A.B.C. POWERS, a term used to denote the three leading nations of southern South America, Argentina, Brazil and Chile. The term refers particularly to their informal association, including the exchange of friendly speeches and official visits, which began about 1905 and was formalized in a five-year treaty in 1915. The treaty pledged the A.B.C. states not to war on each other without first attempting a neutral investigation of the causes of the conflict, but it was never implemented and had no lasting effect.

The most significant accomplishment of the A.B.C. countries was their joint mediation between the United States and Mexico in 1914. The mediation effort followed the U.S. bombardment of the port of Veracruz, Mex. (April 21–22, 1914). The mediation conference was held from May to August of that year at Niagara Falls, Ont. The good offices of the A.B.C. mediators contributed to a solution of the immediate dispute between Mexico and the United States if only by providing time for further diplomatic negotiations and, as it happened, for a change of presidents in revolutionary Mexico which worked to the advantage of the policy being pursued by Pres. Woodrow Wilson.

The importance of this South American "triple entente" lies in the indication it provided of the sensitivity of even remote Latin American nations to United States intervention south of the Rio Grande, and in the wider reputation it gave those nations as active partners in hemispheric affairs. (T. F. McG.)

ABD-AL-MALIK ('ABD-AL-MALIK IBN MARWAN) (*c.* 647–705), Omayyad caliph from 685 to 705 and reorganizer of the Arab Muslim empire after the civil war of 680–692, was born at Medina in Arabia and lived there until 683. His father, Marwan I, was proclaimed caliph in Damascus in June 684 but was assassinated in April 685. Abd-al-Malik succeeded him, but was at first recognized only in Syria and Egypt. Several years were spent in recovering the empire. The rival claimant, Abdullah ibn al-Zubair, of Mecca, who was at first acknowledged in Iraq also, was defeated in 692 by Abd-al-Malik's able general al-Hajjaj. There were also bands of Kharijite and other rebels to be subdued and the Byzantines to be held in check. Eventually control was reasserted. and the closing years of the reign were prosperous. Frontier campaigns recovered lost territories (as in central Asia) or prepared for further advances (as by establishing a firm base at Kairouan in Tunisia). Important internal changes were also made. Arabic became the official language in the financial offices instead of Greek or Persian. The first Islamic gold dinars were minted. To al-Hajjaj were due both the founding of a new garrison city for Iraq at Wasit, and the edition of the text of the Koran with vowels. Abd-al-Malik died in Damascus in Oct. 705. See CALIPHATE (W. M. WT.)

ABD-AL-RAHMAN, the name of five Omayyad rulers. amirs and caliphs of Cordoba in Muslim Spain. (See CÓRDOBA, CALIPHATE OF)

ABD-AL-RAHMAN I (Abd-al-Rahman ibn Mu'awiya ibn Hisham) (reigned 756–788) escaped the massacre when the Abbasids overthren the Omayyad caliphate in Syria in 750 (see CALIPHATE). Abd-al-Rahman after adventurous wanderings accepted an invitation to intervene between two warring Muslim factions in Spain. His energy. generalship and political vision enabled him to master a bewildering situation and to found, in 756, an independent amirate centred on Córdoba. With a standing army of mercenaries he temporarily repressed the rivalries of the Arab aristocracy and the anarchic tribalism of the Berbers in Spain, while defending his territories against invasions organized by the Abbasid caliph of Baghdad and the ruler of Meknès. His internal reforms, which included the formation of a council of state, the reorganization of the judiciary under a senior cadi and the division of Spain into six military provinces, together with his embellishment of Córdoba (where he constructed the famous mosque with its schools and hospitals) and his clemency to the Christians, have led historians to treat him as the equal of Charlemagne, the defeat of whose army in 778 at Roncesvalles (*q.v.*) by the Navarrese marked the end of a Frankish invasion of Abd-al-Rahman's domains.

ABD-AL-RAHMAN II (reigned 822–852), son of the amir al-Hakam I, was the fourth Omayyad amir of Córdoba. In spite of internal troubles, increasing seditiousness on the part of his Christian subjects and wars with the Franks, his reign was noted for the cultivation of the arts and sciences and for the enlightened encouragement of commerce and public works.

ABD-AL-RAHMAN III (Abd-al-Rahman ibn Mohammed ibn Abdullah) (reigned 912–961), the eighth and perhaps the greatest Omayyad ruler of Cordoba, was the first to use the title of caliph in Spain (Jan. 16, 929). He succeeded to the throne at the age of 22, when Omayyad rule was crippled by tribal warfare among the Arabs and by strife between them and Muslims of Spanish descent, while the greater part of Andalusia had seceded under the leadership of Ibn Hafsun. The first ten years of his reign were spent in restoring central authority, the rest in defending his northern borders against the inroads of the Leonese and in stemming the westward advance in north Africa of the Fatimids, who also claimed the caliphate. For a time his navy mastered the western Mediterranean, and he maintained diplomatic relations with the Byzantine emperor and with the princes of southern Europe. Under his rule Cordoba, with 500,000 inhabitants, was the largest and most civilized city of Europe. The seat of Europe's first academy of medicine, a centre for geographers, architects, craftsmen, artists and scholars of every kind, it rivaled for a brief period the splendour of Alexandria in the 4th century B.C.

ABD-AL-RAHMAN IV, styled al-Murtada (reigned 1018–1023), and ABD-AL-RAHMAN V, styled al-hlustazhir (reigned 1023–1024), succeeded to the caliphate in the death agony of the Omayyad dynasty. Both were puppets of factions which soon deserted them. The first was killed while fleeing from a battle in which his troops were victorious, while the second was dismembered, two months after his proclamation, by a revolutionary mob headed by his cousin.

See R. Altamira. "The Western Caliphate," *Cambridge Mediaeval History,* vol. iii (1922); P. K. Hitti, *History of the Arabs,* 5th ed. (1951). (K. GA.)

ABD-AL-WADID DYNASTY (ZEIYANIDS or BENI ZEIYAN), a dynasty nhich ruled at Tlemqen (*q.v.*) in northwestern Africa from 1239 to 1554. In 1239, nhen the empire of the Almohads (*q.v.*) was breaking up, the amir Yaghmorasen, of the Abd-al-Wadid section of the Berber Zenata tribe, set up a new kingdom at Tlemqen, with the support of other Berber tribes and of immigrant Arab groups. This kingdom, however, had neither geographical unity nor fixed frontiers, being peopled mainly by Zenata tribesmen and equally nomad Arabs, and its internal life was much disturbed. The amirs, being unable to find enough Berbers for their armies, were forced to recruit from the unreliable Arab tribes, and their best troops were used for the suppression of internal rebellions. Attempts at expansion eastward and westward failed, and twice during the 14th century the kingdom was annexed by the Marinids of Fez. More than once also the Abd-al-Wadids acknowledged the Hafsids of Tunis as suzerains.

Tlemcen, on the trade route between the Mediterranean ports and Saharan oases, was long prosperous, and the Abd-al-Wadid amirs encouraged the growth there of Andalusian civilization. Several masterpieces of Spanish-Moorish art still bear witness to the city's past splendour. The Abd-al-Wadid kingdom, which had been declining since the 15th century, was overwhelmed by Ottoman Turkish troops from Algiers in 1554.

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ABD-EL-AZIZ IV (ABD-AL-AZIZ IBN AL-HASAN) (1878–1943), sultan of Morocco from 1894 to 1908, nhose reign nas marked by the failure of the sherifian empire to modernize itself by its own efforts. When Abd-el-Aziz succeeded his father Mulay el-Hasan at the age of 16, the government was carried on for six years, on traditional lines, by his late father's chamberlain, Si Ahmed ben Musa, who acted as regent. On the latter's death in 1900 the young ruler, nhose mother was a Circassian and who was glad to seek European advice, attempted to modernize the country and in particular to reform the methods of taxation. These

well-meant endeavours, defeated because of the complete lack of administrators trained on modern lines, caused great resentment among influential notables of the old school This was further accentuated by the sultan's indulgence in childish and often fantastically expensive hobbies. The Anglo-French agreement of 1904, which deprived him of the hope of British aid to resist French encroachments, was a further blow. Nor did the German-sponsored conference of Algeciras (1906) help him in view of the increasing internal anarchy. A pretender, known as Bu Hamara, who claimed to be the sultan's elder brother, headed a rising and all but captured Fez. Though driven back he maintained himself in, the eastern provinces. In 1907. the sultan's brother Mulay Abd-el-Hafidh raised the standard of revolt in the southern capital, Marrakesh. After seeking a loan in France, Abd-el-Aziz marched on Marrakesh in July 1908. His forces were however routed (Aug. 19, 1908) and he himself took refuge with the French troops established near Casablanca. Later pensioned by his brother, he spent the rest of his life at Tangier. *See* MOROCCO: *History.*

(N. BA.)

ABD-EL-KADER (ABD-AL-KADIR) (1808–1883), Algerian national leader, was born near Mascara in northwestern Algeria on Sept. 6, 1808, the third son of Mahi-ed-Din, head of the Kadria Muslim sect. Inured to hardship from early childhood, he became a fine horseman. He also received a sound education and grew up to be very devout. He made the pilgrimage to Mecca in 1827. In 1832, before the death of Mahi-ed-Din, who in 1832 had declared a holy war against the French in Algeria, Abd-el-Kader was proclaimed amir of Mascara. He built up his power astutely, taking advantage of the mistakes of the French and, when the French negotiated with him in 1834, making it clear to the Muslims that the French regarded him as the Muslims' leader.

Success, however, eluded him, and although he won a victory at La Macta (June 28, 1835) he could not prevent Gen. Bertrand Clauzel from sacking Mascara in December and was defeated by Gen. T. R. Bugeaud at Sikkah (July 6, 1836). Resourceful in adversity, he entered into negotiations. and the treaty of Tafna (May 30, 1837) saved his prestige just when the tribes were going to desert him. He still had difficulty, however. in establishing his authority over the tribesmen because of the rivalries of the different Muslim brotherhoods.

In 1839 Abd-el-Kader declared that the French by uniting Constantine and Algiers had broken the Tafna treaty, and holy war was again proclaimed. He laid waste the Mitidja and harried the French troops. In 1840, however, the French decided to compensate themselves in Algeria for the loss of prestige they had suffered over the Eastern Question and Bugeaud was given command of a reinforced army of 106.000 men. Abd-el-Kader lost Tlemcen in 1842, his Moroccan ally was defeated at Isly in Aug. 1844, and his success at Sidi Brahim (Sept. 1845) served only to postpone the French victory. He finally surrendered on Dec. 23, 1847, his only condition being a safe-conduct to the east for himself and his family. Although this was agreed. he was arrested and imprisoned in France first at Toulon, then at Pau and at Amboise (1848–52). He wrote at this time a philosophical treatise which was translated as *Rappel à l'intelligent, avis à l'indifférent.* Finally. on Oct. 16, 1852, he was released and, after a stay of nearly three years in Bursa in Turkey, he settled in Damascus (1855). There in 1860 he saved 12.000 Christians from a crowd of fanatical Muslims (for this he was awarded the *grand cordon* of the *Légion d'Honneur*). On a last visit to Paris (1863–65) he tried in vain to influence Napoleon III's Algerian policy. He died in Damascus during the night of May 25–26, 1883. *See* ALGERIA: *History.*

See Gen. Paul Azan, *L'Émir Abd-el-Kader, 1808–1883* (1925); P. d'Estailleur-Chantereine, *Abd-el-Kader: l'Europe et l'Islam au XIXème siècle* (1947). (L. G.)

ABD-EL-KRIM (MOHAMMED ABD-AL-KARIM AL-KHATTABI) (1881–) achieved fame as leader of the resistance in the Moroccan Rif mountains to the implantation of the Spanish protectorate. His father, a caid of the Berber tribe of Ait Wariyagher, or Beni Uriaghel, gave him a Spanish education and he became *qadi al-qudat* ("chief Muslim judge") at Melilla and editor of the *Telegrama del* **Rif.** First known as friendly to the Spaniards, he took offense at a slight offered him by a Spanish officer, was imprisoned, then fled to Ajdir near Alhucemas and organized armed resistance among the Beni Uriaghel., In 1921 he achieved a tremendous success by completely routing a Spanish force of 20,000 men under Gen. M. F. Silvestre and pursuing them into the suburbs of Melilla. He then organized the whole of the Rif and much of the country to the east into a rudimentary state under his own leadership. The Spanish withdrew from the interior and maintained themselves only in Tetuan. In 1925, however, the French advanced from the south into the valley of the Wargla, from which Abd-el-Krim had drawn supplies. He thereupon attacked them also and in the first onslaught almost reached Fez. This produced a combined Franco-Spanish reaction. The Spanish dictator, Primo de Rivera, organized a successful landing at Alhucemas, in the immediate neighbourhood of Abd-el-Krim's capital, Ajdir; while Marshal Pétain took charge of a French army of 160.000 men and attacked from the south. Soon the end was no longer in doubt; in May 1926 Abd-el-Krim surrendered to the French forces and was sent into exile on the island of Réunion. In his heroic struggle he had displayed great qualities, both military and administrative. If the technical disparity between Morocco and Europe had been no greater than it was in earlier ages he might well have succeeded in driving out the foreigners. But times had changed, and there was no possibility of restoring Moroccan independence until a new generation had grown up, educated in modern schools and methods. While himself a Berber, Abd-el-Krim was a good Arabic scholar and the administration which he introduced was essentially Arab.

After he had spent 21 years in exile on Réunion, the French government in 1947 authorized his residence in the south of France. While passing through the Suez canal he was persuaded by north African emissaries to accept from King Farouk an offer of refuge in Egypt. In Cairo, he presided over the organization known as the Maghrib office. He was, however, out of sympathy with nationalist leaders of the new school and, while disapproving of terrorism, was in other respects entirely intransigent. After the restoration of Moroccan independence, Sultan Mohammed V invited him to return to Morocco. This he refused to do as long as foreign troops remained on north African soil.

See W. *B* Harris, *France, Spain and the* **Rif** (1927). (N. BA.)

ABDERA (modern AVDIRA in the *nomos* of Xanthi in Greece), an ancient town on the coast of Thrace, near the mouth of the Nestos river, almost opposite the island of Thasos. An attempt in the 7th century B.C. by Greek colonists from Clazomenae to occupy the site failed; but the people of Teos, evacuating their homes when the Persians under Cyrus overran Ionia (*c.* 540 B.C.), succeeded in establishing a colony there. which developed a brisk trade with the Thracian interior. Abdera was a prosperous member of the Delian league in the 5th century but mas crippled early in the 4th century B.C. by the incursions of Thracian marauders and declined sharply in importance. The air of Abdera was proverbial in causing stupidity, but among its citizens were the philosophers Protagoras and Democritus. The ruins both of the ancient tonn and of a medieval settlement survive in the neighbourhood of Avdira.

ABDIAS, PROPHECY OF: *see* OBADIAH.

ABDICATION, the renouncing of office and of power before the end of the term for which it was assumed. In ancient Roman law *abdicare* meant primarily "to disown," as when a father disowned a son, a h o was thereby disinherited; but the word was also used in Latin as meaning "to renounce." In modern usage the word "abdication" is generally confined to signifying.the renunciation of supreme power in a state. When it is said that a potentate abdicated, it may be implied that he did so voluntarily. But in many cases where abdication is alleged there is an obvious element of constraint, a show of willingness being put forward in order to avoid the consequences of what would otherwise have to be called deposition. Even so, in arguing that James II of Great Britain "abdicated" by his desertion of the kingdom, the Whigs of 1689 seemed to be straining the sense of the word.

Celebrated voluntary abdications include those of Sulla, of

Diocletian and of the emperor Charles V. The abdication of Edward VIII (*q.v.*) of Great Britain was the result of conflict between personal and political interests. Abdications in the face of military disaster, revolution or the threat of revolution include those of Napoleon I in 1814 and in 1815; of the French, Bavarian and Austrian sovereigns in 1848; of Tsar Nicholas II of Russia in 1917; of the German emperor William II and of the rulers of Bavaria, of Saxony, of Baden and of Wiirttemberg, as also of the tsar of Bulgaria, after World War I; of Kings Victor Emmanuel III of Italy, Leopold III of Belgium and Michael of Rumania after World War II and during the Communist subjugation of eastern Europe; and of King Farouk of Egypt in 1952.

ABDOMEN, the belly, the body cavity lying between the chest or thorax above and the pelvis below. The diaphragm is its upper boundary. There is no wall or clear-cut boundary between it and the pelvis. It contains organs of digestion and the spleen, which are surrounded by a serous membrane, the peritoneum. See ANATOMY, GROSS; GASTROINTESTINAL TRACT.

ABDOMEN, SURGERY OF. The diseases of this region are dealt with generally in the article GASTROINTESTINAL TRACT, DISEASES OF, and under their own names (*e.g.,* APPENDICITIS).

The main barriers to be overcome in the advancement of abdominal surgery were pain and infections. The first was overcome by the introduction of ether in 1846 and chloroform in 1847. Prevention or reduction of infection became possible after the introduction of antiseptic drugs in surgery in 1867, and was further advanced in the latter half of the 19th century through the development of aseptic techniques. With further improvement in the selection of anesthetic and analgesic drugs and in methods of administration, the length of surgical operations could be increased without danger to the life of the patient. Proper preparation of the patient before the operation and adequate care afterward still further increased the safety of surgery, even when it involved extensive surgical procedures. (See also ANESTHESIA AND ANESTHETICS.)

Discovery of the therapeutic value of sulfa drugs and antibiotics greatly diminished the incidence of postoperative infection and further decreased the danger of abdominal surgery. (See also ANTIBIOTICS; SULFONAMIDES.)

Types of Operations. — Operations on the abdomen may be elective or emergency. The former are those planned beforehand and executed at a deliberately chosen time. Emergency surgery is that which has to be performed at once or within a very short time. In some cases the nature of a contemplated operation is envisioned beforehand; in others it is determined only after the abdomen is opened, that is, after exploratory laparotomy.

Gastrointestinal Surgery. — The stomach and the small and large bowel are the major organs in this category.

The commonest stomach operations are those performed for cancer or ulcer. The stomach may be removed in *toto* (total gastrectomy) or a portion may be removed (partial gastrectomy). In the operation called gastrojejunostomy an artificial communication is made between the stomach and a loop of small bowel (jejunum) in order to bypass a duodenal ulcer or a benign pyloric stricture.

Gastrostomy is an operation employed on the stomach of patients suffering from constriction of the esophagus. It consists of making an opening in the stomach with an outlet on the anterior abdominal wall. Food is introduced into the stomach through this opening.

Operations on parts of the small bowel such as the duodenum, jejunum or ileum are employed when parts become gangrenous, as in intestinal obstruction or mesenteric thrombosis, or when they are invaded by malignant tumours. These conditions necessitate resection (removal) of the affected portion of the bowel. Among affections of the large bowel are appendicitis and cancer. Cancer may affect any part, but the rectum and the sigmoid are most often attacked. If cancer is detected early — that is, before there is involvement of other structures — it is possible to remove the diseased portion with the hope of a cure or of five-year survival.

Strangulation of loops of the bowel by a muscular ring of the abdominal wall (external hernia) or by peritoneal bands within the abdominal cavity (internal hernia) requires immediate surgical intervention, ranging from mere cutting of the ring or band to resection of a loop of bowel if gangrene has developed.

Glands of the Digestive System. — Glands include the liver (with the gall bladder and extrahepatic biliary passages) and the pancreas. Resection of a portion of the liver was done occasionally in the second half of the 19th century for wounds or for removal of echinococcus cyst or carcinomatous growth. With the development of the control of hemorrhage by electrosurgery and particularly by suture methods, operations upon the liver ceased to be a rarity. Partial liver resection now is performed not only for the conditions mentioned above but also, for example, to expose branches of the biliary ducts and utilize them for establishment of anastomosis with a loop of jejunum.

Operations upon the gall bladder include several procedures— cholecystostomy, cholecystectomy, cholecystogastrostomy and cholecystenterostomy.

Cholecystostomy implies the formation of a fistula between the gall bladder and the exterior surface of the abdomen. It is done occasionally after the removal of gallstones by inserting one end of a rubber tube into the gall-bladder cavity and bringing the other end outside, thus allowing bile to flow outside the body.

Cholecystectomy denotes removal of the gall bladder. It is usually performed for chronic diseases of the gall bladder or after gallstones have been cleared. Cholecystogastrostomy consists of making an artificial communication between the gall bladder and the stomach. In cholecystenterostomy such a communication is made between the gall bladder and a loop of small bowel, usually the jejunum. These operations are performed to sidetrack the common bile duct when the latter is obstructed and there is no possibility of removing the obstruction, as for instance when the duct is compressed by a malignant tumour from the outside.

Cholecystojejunostomy or choledochojejunostomy is one of the surgical steps in removal of the pancreas with a portion of the duodenum, an operation known as pancreatoduodenectomy.

Although some comparatively simple operations on the pancreas were performed in the last quarter of the 19th century, it was not until the 20th century that the more complicated operative procedures, such as removal of stones and resection of part of or even the entire pancreas, were attempted.

An operation is employed in which an artificial communication is established between the vena cava inferior and the vena porta (Eck's fistula), for relief of ascites or of hemorrhages from the veins of the lower esophagus, caused by cirrhosis of the liver.

Other Procedures. — These include sympathectomy, removal of the sympathetic nerves for spasm of the blood vessels in the legs; vagotomy, or division of the vagus nerves to the stomach to decrease the secretion of acid gastric juice; removal of the spleen for a variety of hematologic conditions; and replacement of the aorta with grafts for aneurysm or arteriosclerotic obstruction.

(J. L. SK.; P. V. H.)

'ABDUH, MOHAMMED (1849?–1905), a pioneer of modern Islamic thought in Egypt, whose legacy of personal character and educational leadership has become formative in Arab history. After a traditional mosque-school education, he became a devotee of Sufi discipline according to the Shadhili order, until he encountered Jamal al-Din al-Afghani, tireless advocate of Pan-Islamic revival, under whose powerful influence he was stimulated into fervent political and journalistic activity. Exiled to Syria in 1882, he traveled in France, Tunis and Lebanon. Returning to Egypt in 1888, he became convinced that the future called for a more Fabian approach. Thus he set himself to instigate wide legal and legislative reforms, to improve student conditions in al-Azhar university and to develop worthier standards among the sheikhs. But inertia and obscurantist hostility finally robbed him of any substantial fulfillment of his aspirations. He died on July 11, 1905.

It was this apathetic spirit of taqlid, or blind appeal to book-authorities, that 'Abduh sought by his writings to banish. His most significant works were an unfinished Koranic commentary and a treatise on divine unity (Risalat *al-Tawhid*) in which he set out his conviction of the essential rationality of Islam. He pre-

supposed the corpus of orthodox theology, aiming only to rid it of this incubus of traditionalism — a negative but urgent task in his day. On the positive side, he tended to a placid concept of faith, "in the knowledge that every sound speculation leads to a belief in God as he is described in the Koran" (*Risalat,* p.10). Holding this harmony between sound natural reason and revealed theology, he did not examine further his assumption that Islam was the religion of reason and the finally perfect faith, or delve into attendant problems. In these terms of attained ultimacy, he interpreted the familiar phrase describing Mohammed as "the seal of the prophets."

'Abduh's greatest achievement lay in the reforming range and vigour of his official *fatwas* as grand mufti of Egypt and in the devotion his personality evoked among his disciples, notably Rashid Rida, Taha Husayn and Mustafa Abd al-Raziq.

See C. C. Adams, ***Islam and Modernism in Egypt*** (1933).

(A. K. CR.)

ABDUL-AZIZ (1830–1876), Ottoman sultan of Turkey, second son of the sultan Mahmud II, was born in Istanbul on Feb. 9, 1830, and succeeded his brother Abdul-Mejid I as sultan on June 25, 1861. He belonged to the Mevlevi sect (dancing dervishes) and loved music, painting and wrestling. Between 1861 and 1871 Abdul-Aziz cultivated good relations with Great Britain and France, with whose collaboration the troubles in Syria, the Balkans and Crete were settled. He was the first Ottoman sultan to visit Egypt (1863) and western Europe (1867). At the same time he continued his predecessors' policy of westernizing Ottoman institutions. On the suggestion of the French government, a council of state was established; an imperial college was opened for both Muslims and non-Muslims; and the first Ottoman civil code was promulgated. Abdul-Aziz enriched himself through the constant issue of state loans but squandered money extravagantly. He also received valuable gifts from Ismail Pasha, the khedive of Egypt, for making the succession to the khediviate hereditary from father to son in direct line and for extending the khedive's prerogatives.

After the French defeat in the Franco-German War, Abdul-Aziz deprived the grand vizier of his prerogatives and made himself an absolute monarch. Abandoning western ideas, he turned to Russia for friendship. In 1870 he signed the firman creating an exarchate in Bulgaria. Finally, however, insurrections in Bosnia and Hercegovina (1875) and in Bulgaria (1876) caused an outbreak of Muslim discontent in Turkey itself and of fanaticism against Russia and the sultan. Abdul-Aziz was deposed on May 29, 1876, and his death in Istanbul four days later is attributed to suicide.

(E. Z. K.)

ABDULHAK HAMID (1852–1937), Turkish poet and playwright, who introduced western influences into Turkish poetry, was born in Istanbul, Jan. 2, 1852, and educated in Paris and Teheran where his father, Hayrullah Efendi, a famous historian, was ambassador. He held diplomatic posts in Paris and Bombay, where his wife became mortally ill. Deeply affected, he wrote his poetic masterpiece Makber (1885). Later, when counselor in London (1885–1908), he remarried, and subsequently became ambassador in Brussels, senator (1914) and, finally, member of parliament in Ankara. He died in Istanbul, April 12, 1937.

A follower of the Tanzimat school of literature which developed from the movement for political reform, he was strongly influenced by Shinasi, Ziya Pasha and especially Namik Kemal. He soon broke with classical tradition, introducing western genres, techniques and ideas into poetry. Shakespeare and Victor Hugo greatly influenced him. His poems, mainly romantic and contemplative, are obsessed by ideas of death and human destiny. His best dramas (Tarik, *Tezer,* Eshber, *Ibn-i Musa, Abdullahüssagir,* etc.), written between 1876 and 1885, are inspired by Muslim history, though *Finten* (1887), his own favourite, portrays London society.

His powerful influence completely changed literary taste in Turkey, and paved the way for the more radical reforms of Tevfik Fikret and his successors.

See E. Rossi, "In morte del poeta turco Abd ul-haqq Hamid," in ***Oriente Moderno*** 17 ***(1937)***; A. Fischer, *Abdülhaqq Hamids* ***dramatische*** *Ruhlar,* text with German trans. (1941).

(F. I.)

ABDUL-HAMID I (1725–1789), Ottoman sultan of Turkey, succeeded his brother Mustafa III on Jan. 21, 1774. He was a practical man, but at the same time superstitious, believing in his own sanctity. During his reign, the decline of Turkey became more pronounced: the disastrous treaty of Kuchuk Kainarji (1774) was concluded with Russia; Bukovina was ceded to Austria (1775); and the Russian annexation of the Crimea was recognized (1784). In order to prevent Russian schemes for the partition of his territories, the sultan in Aug. 1787 declared war on Russia and Austria, in accord with the Russian plans, joined in the war against Turkey the next year. Abdul-Hamid tried to reorganize his army with the help of French experts, but his efforts were frustrated by fanatics. He died on April 7, 1789, before the end of the war.

(E. Z. K.)

ABDUL-HAMID II (1842–1918), Ottoman sultan of Turkey from 1876 to 1909, was born in Istanbul on Sept. 21, 1842. A son of the sultan Abdul-Mejid I, he succeeded to the throne, at the deposition of his brother Murad V, on Aug. 31, 1876. Brought to power by a group of liberals led by Midhat Pasha (*q.v.*), he proclaimed the first Ottoman constitution on Dec. 23, 1876.

Circumstances, however, were ill-suited for liberal developments. Indignation had been aroused throughout Europe by the savage repression of the Bulgarian rising of May 1876; peace had not yet been ratified with Serbia; and the treasury was empty. Then, early in 1877, the disastrous war with Russia began (see RUSSO-TURKISH WARS). Though the hard terms of the treaty of San Stefano (*q.v.*) were mitigated mainly through British efforts at the congress of Berlin (*q.v.*), it became clear to the sultan that he could expect little more help from the western powers whose pressing requests for further reforms he was obstinately resisting. The first Turkish parliament, which had met in March 1877, was dismissed and the constitution suspended in Feb. 1878. Midhat Pasha was exiled in 1881 and died by violence in 1883. Thenceforward until 1908 the sultan's rule was absolute.

After the French had occupied Tunisia (1881) and the British had consolidated their hold over Egypt by overthrowing Arabi Pasha (1882), the sultan turned more and more to Germany for support. Germans were employed to re-organize his finances (by a decree of Dec. 1881 many of the imperial revenues had been handed over to the public debt administration for the satisfaction of bondholders) and to train the Turkish army. In return for this help, concessions had from time to time to be made to Germany, culminating in 1899 in permission to construct the Baghdad railway (*q.v.*).

Though he resented the Bulgarian occupation of eastern Rumelia in 1885, Abdul-Hamid was able to maintain toward Bulgaria an attitude astutely calculated to suit both German and Russian wishes. In Armenia, however, there was agitation from 1890 onward for the reforms promised at the congress of Berlin, and in 1894 a serious rebellion broke out. When this was ruthlessly suppressed, the European powers demanded reforms. The granting of these (autumn 1895) was followed by massacres of Armenians both in Armenia itself and also in Constantinople (mod. Istanbul), and the reforms came to nothing.

Meanwhile Crete had been constantly in turmoil, and Greek support for the Cretans led in 1897 to war. In this the Turks were easily successful (see GRAECO-TURKISH WAR, 1897) and gained a small rectification of the frontier from Greece, but a few months later Crete was taken in trust by Great Britain, Russia, France and Italy who appointed Prince George of Greece as their mandatory. Germany and Austria did not participate in this, and in 1898 the sultan received the visit of the German emperor William II.

In his opposition to European pressure, Abdul-Hamid had always insisted on his role as the champion of Islam against Christian aggression. Pan-Islamic propaganda was encouraged; the privileges of foreigners in the Ottoman empire were curtailed; the Hejaz railway was pushed on toward the Muslim holy places in Arabia; and emissaries were sent far afield to preach Islam and the caliph's supremacy. This appeal to Muslim sentiment, however, failed to prevail over the disaffection caused by Turkish misgovernment. In Mesopotamia and Yemen disturbances were endemic,

and in the nearer parts of the empire the loyalty of the army and the people could only be maintained by a police system of espionage and delation. Obsessed by the fear of assassination, Abdul-Hamid kept himself in fortified seclusion in the palace of Yildiz.

These conditions, together with fresh resentment at Turkish humiliations in the Balkans, led at last to the military revolution of the Young Turks *(see* TURKEY: *History)* in *1908.* Abdul-Hamid capitulated, and on July *24, 1908,* the restoration of the suspended constitution of *1876* was announced. The sultan, however, despite his correct behaviour, was suspected of intriguing with the reactionary elements in the empire, and this suspicion was confirmed by his acquiescence to the counterrevolution of April *13, 1909,* when the new regime was temporarily overthrown. When the Young Turks' army from Salonika restored the new regime, Abdul-Hamid mas deposed and his brother was proclaimed sultan as Mohammed V (April *27*). Confined at first in Salonika, Abdul-Hamid was in *1912* brought back to Constantinople. He died in the palace of Beylerbeyi on the Bosporus on Feb. *10, 1918.*

Abdul-Hamid had a great capacity for work: before his accession, unlike any other Ottoman prince, he had managed a farm. His system of personal rule, however, though apparently successful for many years, was an anachronism. An opportunist, he was not vindictive, but he had no friends and was so mistrustful of other people that he used to extract his own teeth and prepare his own medicines.

See Sir E. Pears, *Life of Abdul-Hamid* (1917); Joan Haslip, *The Sultan: the Life of Abdul Hamid* (1958). (E. Z. K.)

ABD-UL-ILAH (1913–1958), regent of Iraq from *1939* to *1953* and crown prince thereafter, was born at Taif, the son of Ali ibn Husain who for a few months was king of the Hejaz. He accompanied his father thence to Baghdad in *1926* after the loss of the Hashemite family's throne and position in peninsular Arabia. Educated at Victoria college, Alexandria, interested in racing and polo, society and travel and possessing an attractive, intelligent personality, the amir Abd-ul-Ilah was called unexpectedly to act as regent for his cousin and nephew Faisal II when the latter, a child of four, succeeded to the throne of Iraq as a result of the death by accident of the boy's father, King Ghazi (April 4, *1939).*

Abd-ul-Ilah showed throughout his regency an admirable loyalty and affection to the boy-king and resolutely upheld, with gifts and powers which steadily developed, the position of the throne. Compelled to leave Iraq for some weeks in *1941* on the seizure of power by Rashid Ali, he returned with British assistance; and thereafter, in close collaboration with Nuri as-Sa'id and other moderate statesmen, he opposed the more violent forms and personalities of local nationalism and saw Iraq's advantage in a policy of collaboration with the west. He paid numerous state visits to foreign capitals between *1945* and *1953* and, without unconstitutional action, played a considerable, indeed a central, part in Iraqi politics. Relinquishing his functions to Faisal II in *1953,* Abd-ul-Ilah remained the king's constant adviser and supporter. He was assassinated with the king in the revolutionary uprising in Baghdad on July *14, 1958. See* IRAQ: *History.* (S. H. *Lo.)*

ABDULLAH IBN HUSAIN (1882–1951), amir of Transjordan from *1921* to *1946* and king of Jordan from *1946* to *1951,* may be said to have created that country. Born in Mecca, the second son of the sharif Husain (*q.v.;* later king of the Hejaz), he was educated in Turkey and became a member for Mecca in the Ottoman parliament. He played an outstanding role in preparing the Arab revolt against Turkey in World War I and in *1920* boldly occupied Transjordan, where he was recognized as amir by Great Britain, the mandatory power, in March *1921.* He ruled as a benevolent autocrat, guided by British advisers, adroitly establishing Transjordan as an entity separate from Palestine by exacting a pledge from the British that Jews should not settle there. His Hashemite blood and typically Arab attributes — piety, courage, prowess as a marksman and love of poetry and laughter — endeared him to his people. But his unconcealed ambition to extend his rule to Syria and to form with Syria and Iraq a dominant Hashemite bloc embittered the long-standing feud between the Hashemites and the Wahhabi dynasty of Saudi Arabia. In World War II he sent his army, the Arab legion, to assist British troops in Iraq and Syria. Rewarded in *1946* by the grant of full independence, he retained a treaty with Great Britain, renamed his country Jordan and became king.

When in *1947* the United Nations resolved to partition Palestine, Abdullah was the only Arab head of state to accept the plan. But, on failing to win his Arab neighbours to his view, he joined them in fighting the Jews in Palestine, where his army captured Old Jerusalem and played a decisive part in holding central Palestine for the Arabs. In *1950* he annexed these Arab-held territories to Jordan, thereby incurring the anger of the Egyptian, Saudi Arabian and Syrian governments, which considered that Arab Palestine should constitute a separate state under the control of Haj Amin al-Husaini, former mufti of Jerusalem. Thereafter Abdullah's problems increased. While his country was desperately impoverished by the arrival of thousands of refugees from Palestine, his new Palestinian subjects clamoured for a more democratic constitution. His enemies multiplied, and a plot to murder him was brought to fruition on July *20, 1951,* when he was shot in the Aqsa mosque in Jerusalem by a young Palestinian Arab, a supporter of Haj Amin al-Husaini.

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ABDUL-MEJID I (1823–1861), Ottoman sultan of Turkey, was born in Istanbul on April *23, 1823,* and succeeded his father Mahmud II, on July *2, 1839,* at the age of *16.* Well-educated and able to speak French, Abdul Mejid was also liberal-minded and receptive of western ideas. He came to terms with Mohammed Ali (*q.v.*), the rebel Egyptian viceroy, and then attempted to carry through the program of reforms which he had inherited from his father. On Nov. 3, *1839,* he issued an edict, known as the *Hatti-sherif* ("handwriting") of Gulhane, which contained some provisions regarding human rights. The lives and property of all Ottoman subjects, irrespective of race or creed, were safeguarded, and their right to justice guaranteed; and the incidence of taxation was determined and its collection regulated. A regular system of recruiting was introduced. These regulations heralded a new era known as the *tanzimat,* which was applauded by the liberals of Europe. Abdul-Mejid refused to surrender the Hungarians who had fled to Turkey after the rising in *1849.* His liberal dispositions helped to secure for him the support of Great Britain, France and Sardinia in the Crimeap War (*q.v.*) against Russia. In *1856,* Abdul-Mejid issued a new regulation by which he accorded civil and political rights to his Christian subjects and opened the door to foreign capital. The later years of his life, however, were troubled by a financial crisis and by a conspiracy against him. He died in Istanbul on June *25, 1861.* (E. Z. K.)

ABDUL-MEJID II (*1868–1944*), the last caliph and crown prince of the Ottoman dynasty of Turkey, was born on May *30, 1868,* in Istanbul, the son of the sultan Abdul-Aziz and Hayranidil Kadin. Although confined to the palace until he was *40,* Abdul-Mejid was considered to be better-informed than other Ottoman princes of the time, but his inconsistencies and his behaviour created a general impression that he was psychologically affected like his father and his elder brother. In *1918,* when Mohammed V died and Vahid-ed-Din ascended the throne as Mohammed VI, Abdul-Mejid became crown prince, but he lost this title when Mohammed VI fled the country *(1922)* and the sultanate came to an end. He was then chosen caliph, but, four months after the proclamation of the republic, the caliphate was abolished (March *3, 1924)* and members of the Ottoman dynasty were expelled. Abdul-Mejid died in Paris on Aug. *23, 1944.* (M. P. P.)

ABDULRAHMAN (TUANKU ABDULRAHMAN) (1895–1960), the first king *(Yang di-pertuan Agong)* of the Federation of Malaya, was born at Sri Menanti, on Aug. *24, 1895,* the son of Tuanku Mohammed, the ruler *(Yang di-pertuan Besar)* of Negri Sembilan. He accompanied his father to England in *1925* and remained to study law, being called to the bar from the Inner Temple in Nov. *1928.* Returning to Malaya he held a variety of posts in the civil service. After his father's death he was, on Aug. *3, 1933,* elected ruler of Negri Sembilan. A retiring but kindly man who

had inherited from his father a deep respect for constitutional law and a profound sympathy for his people, Tuanku Abdulrahman was admirably fitted to be Malaya's first king when, on Aug. 31, 1957, it became independent. He died at Kuala Lumpur on April 1, 1960. (R. O. WT.)

ABDULRAHMAN, TENGKU (1903–), first prime minister of Malaya, was born at Alor Star, Kedah, on Feb. 8, 1903, a son of Abdulhamid Halim Shah. sultan of Kedah, and a Thai mother. After a long period in England (from 1920), he returned to Malaya in 1931 to enter the Kedah civil service. He remained in Kedah throughout the Japanese occupation in World War II. Thereafter he again went to England and was called to the bar in 1949. On his return to Malaya he took a prominent part in politics as a leader of the United Malays' National organization (U.M.N.O.), succeeding Dato Onn bin Ja'afar as president in 1951. His great achievement as president was to effect the alliance of U.M.N O. with the Malayan Chinese association. This was not easy, since before Malaya's first general election (1955) many members of U.M.N.O. would have restricted the number of Chinese candidates, and Malay religious leaders would have wanted Muslims to vote only for Muslims, *i.e.*, Malays. Tengku Abdulrahman resisted both these communal demands, and his alliance swept the poll, losing only one seat. In Jan. 1956, as chief minister, he headed a *merdeheka* ("freedom") mission to London, when the British government decided to grant Malaya self-government at once and independence by Aug. 31, 1957. He then became independent Malaya's first prime minister, and the success of that independence was largely due to his unselfish zeal, ability and winning personality. In Jan. 1961 he was made a companion of honour. (R. O. WT.)

ABDURRAHMAN KHAN (1844–1901), amir of Afghanistan from 1880 to 1901, was born in Kabul, the son of Afzal Khan and the grandson of Dost Mohammed Khan, the founder of the Mohammedzai (or Barakzai) dynasty. When his father was appointed governor of the northern province of Mazar, Abdurrahman, then about ten years old, went with him. Thereafter his youth was spent mainly in shooting, riding and military training.

Dost Mohammed died in 1863 and was succeeded by his third son Sher Ali Khan, whose elder brothers Afzal Khan and Azam Khan. with Abdurrahman's support, then rose in revolt. For several years civil war was waged with fluctuating fortune. When Sher Ali nas finally victorious Abdurrahman Khan took refuge in Russian Turkistan. Warmly received by the governor, he lived at Samarkand from 1870 to 1880, profiting by his study of the Russian administrative system.

After the outbreak of war between the British and the Afghans (1878), which was followed by the death of Sher Ali and the deportation of his son Yakub Khan to India, Abdurrahman in 1880 returned to Afghanistan where he was heartily welcomed by the people. At a conference held at Kabul on July 22, 1880, the British, then in possession of Kabul and Kandahar, formally proclaimed him amir. All British troops were withdrawn from Afghanistan after Lieut. Gen. Frederick Roberts (later Earl Roberts) had relieved the siege of Kandahar, nhich Ayub Khan, Yakub's brother, had been besieging. Abdurrahman then set to work with great energy and determination to pacify the country and to consolidate his authority. His methods may have been grim and cruel but, as he himself confessed, he had to rule an iron people with a rod of iron. Ayub. who for a time was able to maintain himself in Herat, gave trouble intermittently till his final defeat in 1887.

After establishing law and order Abdurrahman turned his attention to the settlement of border disputes with his powerful neighbours. In 1887 agreement was reached on the demarcation of Afghanistan's northwestern border with Russia. At the end of a series of talks held near Kabul in Oct.–Nov. 1893 with a British delegation led by Sir Mortimer Durand, Abdurrahman was constrained to accept the Durand line as his frontier, relinquishing some of his hereditary rights over the tribes on the eastern border of the country.

In spite of these preoccupations Abdurrahman found time to reorganize the administrative system of the country and to initiate internal reforms. He brought foreign specialists and experts in and imported machinery for making guns, rifles and cartridges; factories were established for the manufacture of boots, soap and candles; distilling apparatus and new agricultural tools mere successfully introduced; the first modern hospital was established; and mines were successfully opened.

Abdurrahman Khan died in Kabul on Oct. 1. 1901.

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(MD. A.)

ABEL, the second son of Adam and Eve (*q.v.*), portrayed in the fourth chapter of Genesis. He was a shepherd and offered the first born of his flock to the Lord, comparable to a faithful Israelite in the nomadic tradition. In a jealous rage. Cain, his brother, slew him, thus committing the "first murder." Cain was a farmer, and many interpreters feel that the story constitutes a polemic against agriculture. Its major concern. however, is the guilt incurred by shedding innocent blood. Cain must become a fugitive because his brother's blood, spilled on the soil and unavenged, puts a curse on him. Matt. xxiii, 35 and Luke xi, 51 cite the blood of Abel as an example of the vengeance of violated innocence. In Heb. xi, 4 and xii, 24 the blood of Abel becomes a type of the blood of Jesus. *See* also CAIN. (J C. RY.)

ABEL, JOHN JACOB (1857–1938), U.S. pharmacologist and physiological chemist, was a specialist in the chemistry of the ductless glands. He was born on May 19, 1857, in Cleveland, O. After attending the University of Michigan, Ann Arbor (1876–79), he was principal of the high school and superintendent of the public schools of La Porte, Ind. (1879–80; 1880–82), receiving his Ph.B. in 1883. After a year of study at Johns Hopkins, Baltimore, Md., he studied chemistry and medicine at several European universities, receiving his M.D. from the University of Strasbourg in 1888. He was lecturer and professor of materia medica at the University of Michigan (1890–93); in 1893 he became professor of pharmacology at Johns Hopkins, and, in 1932. director of the Laboratory for Endocrine Research. From 1909 to 1932 he edited the *Journal* of *Pharmacology and Experimental Therapeutics.*

Abel isolated adrenaline (epinephrine), the blood-pressure raising constituent of the adrenal glands. in the form of a benzoyl derivative. He also isolated insulin in crystal form. He became internationally known through these discoveries and through his many studies on the chemical composition of animal tissue and fluids, albumoses in the tissues. the action of pthaleins, the poisons of mushrooms, hydrolytic products of proteids, carbamic acid and histamin. He died on May 26, 1938, in Baltimore, Md.

ABEL, KARL FRIEDRICH (1723–1787), German musician, one of the last great players of the viola da gamba, and a notable symphonist of the preclassical school, was born at Cöthen, Dec. 22. 1723. He played from 1748 to 1758 under J. A. Hasse in the famous Dresden court orchestra, and, going to England in 1759, became chamber musician to Queen Charlotte.

When J. C. Bach arrived in London in 1762 they became friends and later established a famous series of concerts, known as the Bach and Abel concerts, one of which, in 1775, inaugurated the celebrated Hanover Square rooms. At these concerts, Haydn's symphonies were first publicly performed in England. Abel himself was not only a fine performer on the viola da gamba, but a gifted instrumental composer; his first set of symphonies was published *c.* 1761 and achieved great success. He wrote about 40 symphonies, most of which were published: one was long attributed wrongly to the youthful Mozart (the so-called K. 18). Abel also published several sets of quartets and trio-sonatas, and a set of harpsichord concertos.

After the death of J. C. Bach (1782), he allowed his weakness for alcohol to gain hold upon him, and the last part of his life was clouded by this failing. He died in London, June 20, 1787. Some of his music has been reprinted; it has formal neatness and balance, and considerable melodic facility. His technical knowledge was highly regarded, and he was esteemed as a teacher, one of his most famous pupils being J. B. Cramer, who published some of his adagios (1820).

See S. M. Helm, *Carl Friedrich Abel, Symphonist* (1953). (Cs. Ch.)

ABEL, NIELS HENRIK (1802–1829), Norwegian mathematician. a pioneer in the development of modern mathematics, was born on Aug. 5, 1802, on the island of Finnoy, near Stavanger, Nor.. where his father was a minister. Shortly after Abel's birth, his father was transferred to the parish of Gjerstad, near the town of Risor (southeast Norway), and there the boy grew up, the second of six children. His mathematical talent was recognized, while he was a student at the Cathedral school in Oslo, by a young teacher, B. M. Holmboe (who edited the first edition of Abel's work, in 1839). While still in school he believed he had found a solution of the general quintic equation, but he discovered an error before publication.

In 1820 Abel's father died, mainly from drink, and left the family in poverty. The boy was able to enter the University of Oslo in 1821, sponsored by personal contributions of several of the professors. His first papers were published in 1823 in the new periodical *Magazin for Naturvidenskabene.* The topics were functional equations, integrals and the first instance of the solution of an integral equation. At this time Abel received a small stipend from the mathematics professor Rasmussen, which enabled him to take a trip to Copenhagen to make the acquaintance of the Danish mathematicians. Upon his return Abel found the proof for the result that the general quintic equation or higher had no solution in radical expressions; it was published in a small pamphlet at his own expense. In 1824 he received a government fellowship for mathematical studies in Oslo and abroad. The winter of 1825–26 he spent in Berlin with Norwegian friends, mainly geologists. He had the good fortune of making the acquaintance of A L. Crelle, who became his close friend and protector. Inspired by Abel, Crelle founded the important *Journal fur die reine und angewandte Mathematik,* the first volume of which is filled with papers by Abél. They concern such topics as equation theory, functional equations, integration in finite form, problems from theoretical mechanics and others.

Abel's early mathematical training had been in the formal calculating school typified by Euler. In Berlin he came into contact with the new direction represented by C. F. Gauss and A. L. Cauchy, requiring a much stronger degree of logical stringency. Under this influence he wrote a study of the binomial series, considered to be one of the classics in function theory. It contains the principles of convergent series with special applications to power series (Ostwald's *Klassiker der exakten Wissenschaften,* no. 71).

During the spring of 1826 Abel undertook a journey with his Norwegian friends through Prague, Vienna, northern Italy and Switzerland to Paris. Upon his arrival there he completed his *Mémoire sur une propriété générale d'une classe très-étendue de fonctions transcendentes,* which he himself considered his masterpiece. In this he gives a theory of integrals of algebraic functions —in particular, the result known as Abel's theorem, that there is a finite number, the genus, of independent integrals of this nature. This forms the basis for the later theory of Abelian integrals and Abelian functions. The paper was submitted to the French institute Oct. 30, 1826. Abel had hoped that it would open the door to the French mathematicians, but he waited in vain until his money gave out and he had to return to Berlin. There he completed his first long article on elliptic functions, a topic he had worked on in his student days. Abel returned to Norway heavily in debt. He subsisted by tutoring and a small grant from the university; beginning tuberculosis of the lungs aggravated his situation. In 1828 he received a substitute teaching position. His poverty and ill-health had little influence, however, on Abel's scientific production. He poured forth a great number of papers, principally on equation theory and elliptic functions. Among them are found the theory of the Abelian equations with Abelian groups. The theory of elliptic functions was developed with great rapidity in competition with K. G. J. Jacobi.

By this time Abel's fame had spread to all mathematical centres, and strong efforts were made to secure a suitable position for him. Bernadotte, the king of Norway-Sweden, was addressed directly by a group of members of the French Academy; Abel's friend Crelle worked feverishly to secure a professorship for him in Berlin. But in the fall of 1828 Abel became seriously ill, and his condition deteriorated on a several-day sled trip at Christmas time to visit his fiancée at Froland. He died there on April 6, 1829, at the age of 26. The appointment to Berlin had just been made; posthumously he was awarded, together with Jacobi, the Grand Prix of the French academy for 1830.

Crelle stated in his obituary: "One may say that he was able to penetrate all obstacles down to the very foundation of the problems, with a force which appeared irresistible. . . . He distinguished himself equally by the purity and nobility of his character and by a rare modesty which made his person cherished to the same unusual degree as was his genius."

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ABELARD, PETER (Lat. Petrus Abaelardus; Fr. Pierre Abailard or Abélard) (1079–1142). theologian and philosopher, was the son of the lord of Le Pallet in Brittany south of the Loire. Between *c.* 1094 and *c.* 1106 he studied logic at Loches and in Paris under Roscelin and Guillaume de Champeaux and taught it at Melun and at Corbeil. After one or two years in Brittany he returned to Guillaume's school; but the violent polemics with his master, whom he forced to change views on the nature of universals, made his stay in Paris difficult, He went again to Melun but was soon back in Paris as a teacher on the Mont Ste. Geneviève. After another interval in Brittany he attended Anselm of Laon's theological school *(c.* 1114) but alienated his masters by sharp criticism of their scholarship and went back to Paris as a teacher of logic and theology at Notre Dame. Fulbert, a canon there, entrusted him with the education of his brilliant niece Heloi'se. Abelard's love for her led to the birth of a child and to a secret marriage; Fulbert took his revenge by having Abelard emasculated; whereupon Heloi'se became a nun and Abelard a monk *(c.* 1118). In the monastery of St. Denis, he made himself unpopular by denouncing the worldliness prevailing there; and his success as a theologian prompted other theologians to probe his views on the Trinity. The council of Soissons (1121) ordered his first theological book to be burned and its author to retire to St. Médard. After returning to St. Denis, he fled to Provins because of the storm which he aroused by claiming that the traditional identification of St. Denis with Dionysius Areopagiticus was wrong. Soon he was allowed to found the community of the Paraclete (Le Paraclet, in the vicinity of Nogent-sur-Seine), which was later given to Heloi'se and her nuns. As abbot of St. Gildas de Ruys in Brittany (1125–*c.* 1132), he struggled to rule over corrupted monks, who even tried to murder him. In 1136 John of Salisbury was his pupil on the Mont Ste. Genevibve. In 1140 or 1141 he was faced with a new and stronger attack, led by St. Bernard of Clairvaux (*q.v.*), against his theological doctrines. The council of Sens and the pope condemned him. He decided to appeal to Rome, but on his way there was persuaded by Peter of Cluny to submit to the verdict of the council and make peace with Bernard. From Cluny he passed to the priory of St. Marcel near Chalon-sur-Saône, where he died on April 21, 1142.

The mainspring of Abelard's thought and teaching was his optimism concerning the power of human reason to achieve true knowledge in the natural and supernatural spheres; unaided reason would not lead to "comprehension" of all truth accessible to man, but would "understand" much which is more directly and more completely available through faith. Thus pagan philosophers knew something about God's Trinity; and ancient philosophy (which Abelard knew almost exclusively through the evidence of the Fathers and from Cicero, Aristotle's *Categories* and *De Interpretatione,* a section of Plato's *Timaeus,* Porphyry's *Isagoge* and Boethius) provided sufficient evidence that God had also revealed himself, to some extent, outside Scripture, the incarnation and the church. Reason, philosophy and logic can still walk side by side with faith in the province of theology. The written words of Scripture and of the Fathers must be subjected to the scrutiny of reason; Scripture is God's work, produced through fallible

men, transmitted by fallible scribes. interpreted by fallible apologists; language is liable to innumerable ambiguities and changeable. A healthy skepticism is a steppingstone to knowledge. Should the mind, however, find itself on the verge of an insoluble conflict, Abelard would rather reject Aristotle than St. Paul. The aim of his teaching and writing was to give a more logically argued foundation to Christian doctrine and thus to defeat the contemporary heresies or dangerous views of such thinkers as Roscelin and Gilbert de la Porrée, but St. Bernard, among others, saw in those methods the very source of heresy.

As a philosopher Abelard excelled in his study of the nature of abstraction and in his search for the source of responsibility in human actions. His inquiries into the problem of universals, far from crystallizing in a moderate nominalism or intellectualism, ranged from a critical survey of the opinions of other philosophers to an analysis of the functions — logical and grammatical — of universal words, to a research into the various levels of knowledge and to a metaphysical discussion on the similarities of things and on the relationship between God and universality in created things. His inquest into the components and aspects of human action made him conclude that intention is what makes an action good or bad, independently of its being performed or not.

A man enthusiastically devoted to the search for truth, intellectually self-centred, impetuous and uncompromising, Abelard stimulated and inspired large numbers of pupils, angered — and was feared by — many of his elders and provoked equally stubborn opponents, foremost of all St. Bernard, to fight him. The direct influence of his writings was limited; the indirect influence of his teaching has yet to be assessed. No other works of the early 12th century give as clear a picture as do Abelard's of that deep concern with a vast range of problems or of that critical attitude toward past and contemporary solutions which characterized the period. In his poetical compositions, particularly in his *Planctus,* Abelard also left a mark in the history of Latin metric.

Abelard's extant works may be divided among five groups: (1) theological writings; (2) philosophico-theological writings; (3) logical treatises; (4) letters; and (5) poetical compositions. To the first group belong the successive elaborations of his *Theologiu,* namely, the *Theologia "Summi Boni"* (of which the so-called *De Unitate et Trinitate* is an incomplete text), the *Theologia Christiana* and the *Theologia "Scholarium"* (of which the so-called *Introductio ad Theologiam* is one of the five known recensions); the incomplete *Apologia; Sic et non* (a collection of apparently contrasting passages from the Fathers on various theological topics); the *Expositio in Hexaemeron* and the *Expositio in Epistolam ad Romanos;* the *Sermons;* and some shorter treatises. The second group comprises the *Scito te ipsum* (the *Ethica*) and the incomplete *Dialogus inter Philosophum, Judaeum et Christianum.* The logical treatises include short commentaries on some works by Aristotle, Porphyry and Boethius; longer commentaries *(Logica "Ingredientibus"* and *Logica "Nostrorum petitioni")*; the *Dialectics;* and possibly the *De intellectibus* and the *Sententiae.* The letters comprise his autobiography down to 1132 *(Historia Calamitatum),* five letters to Heloi'se, a letter to St. Bernard and six other letters. The poetical compositions comprise hymns, sequences, the *Planctus* and the *Ad Astralabium filium.*

No complete edition of Abelard's works exists, and a few texts are unpublished. Collected works were edited by F. d'Amboise and A. Duchesne (1616); by Victor Cousin, *Ozivrages inkdits* (1836), and, with Charles Jourdain, *Opera hactenus seorsim edita* (1849–59); and by J. P. Migne, in *Patrologia Latina,* clxxviii (1855). Editions of separate works include those of the *De Unitate et Trinitate* by R. Stolzle (1891); of the *Theologia "Summi Boni"* by H. Ostlender (1939); of the *Apologia* by P. Ruf and M. Grabmann, in *Sitzungsberichte der Bayerischen Akademie der Wissenschaften: Philos.-hist. Abt.* (1930); of *Sic et non* by E. L. T. Henke and G. S. Linderkohl (1851); of the *Logica "Ingredientibus"* (incompletely) and of the *Logica "Nostrorum petitioni,"* under the title *Peter Abelards philosophische Schriften,* by B. Geyer (1919–33); of the short commentaries and of the commentary on Boethius' *De Differentiis Topicis,* under the title *Scritti filosofici,* by *M.* Dal Pra (1954); of the *Dialectica* by L. M. de Rijk (1956); of the *Historia Calamitatum* and other letters by J. T. Muckle, in *Mediaeval Studies,* xii, xv and xvii (1950–55); of the *Hymnarius* by G. M. Dreves (1891; also in *Analecta Liturgica Medii Aevi,* xlviii, 1905); of the *Planctus* by G. Vecchi (1951); and of the poem *Ad Astralabium* by B. Hauréau in *Notices et extraits,* xxxiv, 2, pp. 153–154 (1895). There are English translations of the *Ethics* by J. *R.* McCallum (1935); of the *Letters to Heloïse* by C. K. Scott Moncrieff (1925; 1926); and of the *Historia Calamitatum* by J. T. Muckle (1954).

See also Index references under "Abelard, Peter" in the Index volume.

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ABELL, SIR WESTCOTT STILE (1877–1961), British naval architect and engineer who did much to maintain the standards of British mercantile shipbuilding during and after World War I, was born on Jan. 16, 1877. After professional training at the Royal Naval colleges of Keyham and Greenwich and service in the admiralty as naval constructor, he was in 1910 appointed the first professor of naval architecture at Liverpool university, where he inaugurated a new course in that subject. From 1914 to 1928 he was chief ship surveyor, Lloyd's Register of Shipping, and greatly assisted the government's merchant shipbuilding program during World War I. Sir Westcott was created knight of the British Empire in 1920. Between 1928 and 1941, while professor of naval architecture at Armstrong college, Newcastle upon Tyne, he designed the Dover-Dunkirk ferry steamers. He was the author of several works on shipbuilding. He died on July 29, 1961.

ABENCERRAGES, a family or faction said to have been prominent in palace intrigues in the Moorish kingdom of Granada in the 15th century. The name seems to be derived from that of Yusuf ibn Serragh, head of the tribe under Mohammed VIII of Granada. Ginés Pérez de Hita's romance, *Guerras civiles de Granada,* originally entitled *Historia de los bandos de los zegríes y Abencerrajes* (1595), celebrates the family's feud with the Zegris. A hall in the Alhambra (*q.v.*) is the reputed scene of the massacre of the family *(c.* 1485?). Chateaubriand's *Aventures du dernier Abencérage* (1826; new ed. with historical notes by P. Hazard and M. J. Durry, 1926) also has done much to preserve the name.

ABEOKUTA, town and capital of the province of that name of Western Region, Nigeria, Africa, lies on the east bank of the Ogun river, about 65 mi. N. of Lagos and 48 mi. W. of Ibadan, around a group of rocky outcrops about 600 ft. above sea level. The surrounding country is savanna. Pop. (1952–53) 84,451, (1959 est.) 95,000. Area about 5 sq.mi. The inhabitants are of the Egba branch of the Yoruba (*q.v.*) and have four chiefs of whom the *alake* (king) of Abeokuta is *primus inter pares* ("first among equals").

In spite of the abundance of local stone from the the Aro quarries south of the town, which have supplied granite for much of the new building in Nigeria, the majority of the houses of Abeokuta are of pounded laterite mud with pan (metal) roofs. The more notable buildings include the Ake (residence of the *alake),* the Anglican church, the Centenary hall (1930) and Abeokuta grammar school.

There are six secondary schools, among them the Blaize memorial institute for handicraft training, founded in the early part of the 20th century.

Farming is the main occupation of the inhabitants and the town is a centre for palm kernels and cocoa. A traditional craft is the dyeing of cloth in Yoruba patterns and colours (especially blue). The women of the tom-n have a strong organization for retail trade,

of which they have a virtual monopoly.

Abeokuta is on the main railway from Lagos to the north and on the older trunk road from Lagos to Ibadan, now replaced for through traffic by the shorter road through Shagamu.

According to local tradition Abeokuta ("under stone") was first settled about 1830 by people from townships in Egba forest in the Ibadan area who fled when their homes were destroyed by slave raiders. Their association with the British crown developed after the arrival of Christian missionaries in 1842 (Abeokuta was for a long time the headquarters of the Yoruba mission), through one of whom in 1850 Queen Victoria presented them with two Bibles, in English and Arabic (since twice replaced by British sovereigns). They gave their co-operation in suppressing the slave trade which still persisted along the coast; and in 1893, through the intervention of the governor of the colony of Lagos, a united Egba government was formed to end local rivalries, and a treaty of friendship and commerce was concluded between the alake and the British sovereign. In 1914 the Egba kingdom came formally under British protection on the amalgamation of Northern and Southern Nigeria. See also NIGERIA. (W. H. I.)

ABERCORN, EARLS AND DUKES OF. The 1st earl of Abercorn, JAMES HAMILTON (c. 1575–1618), the eldest son of Claud Hamilton, Lord Paisley, and grandson of James, 2nd earl of Arran (*q.v.*), was probably born on Aug. 12, 1575. He gained favour with James VI of Scotland, who appointed him privy councilor (1598) and hereditary sheriff of Linlithgow (1600). He was created Lord Abercorn (1603), and in recognition of his support of a proposed union between Scotland and England was created earl of Xbercorn, lord of Paisley, Hamilton, Mountcastle and Kilpatrick (1606). Later King James made him a privy councilor for Ireland (1615) and granted him estates in the barony of Strabane. He died at Monkton on March 23. 1618, and was succeeded by his eldest son JAMES (c. 1604–c. 1670), the 2nd earl.

The title of Abercorn, held by the head of the Hamilton family, became a marquisate in 1790 and a dukedom in 1868. JAMES (1811–1885), the 1st duke, was born in London on Jan. 21, 1811, and succeeded his grandfather JOHN JAMES (1756–1818), the 1st marquess. In the house of lords he consistently supported Tory policies and was by Conservative prime ministers appointed lord lieutenant of Ireland (1866–68 and 1874–76). He held strong views on Irish land problems and forced upon the Liberal government several amendments to the Irish land act of 1880. He also laboured to end religious discrimination in education and became in 1879 the first chancellor of the Royal University of Ireland. He died at Baronscourt, County Tyrone, on Oct. 31, 1885.

His son JAMES (1838–1913), the 2nd duke, was born at Brighton on Aug. 24, 1838. He became a member of the household of the prince of Wales (afterward Edward VII) and accompanied him on a visit to Russia in 1866. He was president of the Irish landlords' convention (1888) and opposed land purchase, although this was a Conservative policy; nevertheless after George Wyndham's act (1903) he was among the first to sell land to his tenants. He was a stalwart Unionist and opposed the Home Rule bill of 1912. He died in London on Jan. 3, 1913.

JAMES ALBERT EDWARD (1869–1953), the 3rd duke, was born on Nov. 30. 1869. Like his father and grandfather he supported the Unionist interest. After the passage of the Government of Ireland act (1921) he became a senator of Northern Ireland and served as governor from 1922 to 1945. He died in London on Sept. 12, 1953, and was succeeded by JAMES EDWARD (1904–), the 4th duke.

ABERCRBMBIE, LASCELLES (1881–1938), English poet and critic whose work is distinguished by clarity, intellectual power and keen interest in structure and form. Born at Ashton-upon-Mersey, Cheshire, Jan. 9, 1881, he was educated at Malvern college and studied science at Manchester, 1900–02. He then became a journalist and began to write poetry. His first book, *Interludes and Poems* (1908), was followed by Mary and the Bramble (1910), a dramatic poem — Deborak — and Emblems of *Love* (1912) and prose *Speculative Dialogues* (1913). A leading member of the Georgian group of poets, he collaborated with John Drinkwater, Rupert Brooke and Wilfrid Gibson in the periodical *New Numbers* (1914). His chosen metres, the irregular choric ode and blank verse. reflected his feeling for classical poetry, especially Greek, as did his increasing concern to establish a philosophy of poetry and his interest in prosody.

After World War I, Abercrombie began an academic career with his appointment to the first lectureship in poetry at Liverpool university. There, as professor of English literature at Leeds (1922–29) and London (1929–35), and as reader in English literature at Oxford (1935–38), he showed keen critical and philosophical powers. His critical works include *Thomas* Hardy (1912), An Essay *Towards* a Theory of *Art* (1922), The *Theory* of Poetry (1924) and Poetry, Its *Music and Meaning* (1932). His most mature poetic work, The Sale of St. *Thomas*, a poetic drama the first act of which appeared in 1911, was published in 1931. He died in London, Oct. 27, 1938.

Abercromhie's Collected Poems were published in 1930. A collection of lectures, ***The** Idea of* Great Poetry appeared in 1925. See also O. Elton, Lascelles *Abercrombie* (1939).

ABERCROMBY, SIR RALPH (1734–1801). British soldier, whose command restored discipline and prestige to the British army after the disastrous campaigns in the Low Countries between 1793 and 1799, and who prepared the way for the successful campaign against Napoleon in Egypt, was born on Oct. 7, 1734, at Tullibody, Clackmannanshire, Scot. He was educated at Rugby school and at Edinburgh and Leipzig universities, where. he studied law. Preferring a military career, he entered the army as cornet in the 3rd dragoon guards in 1756, served in the Seven Years' War and was schooled in the methods of Frederick the Great. In 1774 he was elected member of parliament for Clackmannanshire in the Whig interest. His opposition to the American war impeded his professional advancement and, disgusted with politics, he went out of parliament in 1780. On the outbreak of war with France in 1793 he returned to the army and was appointed to the command of a brigade under the duke of York, for service in Flanders. Commanding the rear column, he had to protect the army in its retreat from Holland in the winter of 1794–95. Returning home, he was made a knight of the Bath and appointed to the command of the British forces in the West Indies, in which capacity he seized the French sugar islands. During his absence there he was re-elected to parliament for Clackmannanshire without a contest (1796), but resigned his seat in 1798. He commanded the troops in Ireland in 1797–98 but, finding all his efforts to tighten military discipline and to end the excesses of the militia were thwarted by the Irish government, he resigned the command and was at once appointed commander in chief in Scotland. He served under the duke of York in the second expedition to the Netherlands in 1799. In 1800 he was given the command of the troops in the Mediterranean. After the failure of a descent on Cadiz, he was ordered to Egypt to expel or destroy the army which Napoleon had left there in 1799. Landing at Abukir bay on March 8, 1801, he advanced toward Alexandria. A French attack before daybreak on March 21 was beaten back with heavy loss, but Abercromby was mortally wounded in the hour of victory. He died on board the flagship "Foudroyant" on March 28 and was buried at Malta. His widow was created Baroness Abercromby of Tullibody and Abukir Bay. Major General Hutchinson, who succeeded him in the command and quickly completed the reconquest of Egypt, wrote of him and his troops: "It was my fate to succeed such a man, who created such a spirit and established such discipline among them that little has been left for me to perform, except to follow his maxims and to endeavour to imitate his conduct."

See Lord Dunfermline, Sir Ralph Abercrornby K. B. 1793–1801, a memoir published by Abercromby's third son (1861); Sir John Fortescue, A History of the British Army, vol. iv. part ii (1906). **(A. AL.)**

ABERDARE, HENRY AUSTIN BRUCE, 1ST BARON (1815–1895), British statesman, who was home secretary from 1868 to 1873 and lord president of the council from 1873 to 1874, was born at Duffryn, Aberdare, Glamorganshire, Wales, on April 16, 1815. Coal discovered on the Duffryn and Aberdare estates of the family made him a rich man, always prominent in Welsh affairs. Entering politics as a Liberal. Bruce represented Merthyr Tydfil from 1852 to 1868, and Renfrewshire from 1869 to 1873, when he became a peer. Efficient and conciliatory, he served under

Lord Palmerston and Lord John Russell, gaining a high reputation as undersecretary at the home office (1862–64) and vice-president of the council for education (1864–66). Until his death Aberdare took an active interest in social and economic questions. He presided over several royal commissions and was first chancellor of the University of Wales. From 1882, when he became chairman of the National African company (later the Royal Niger company). he was associated with developments in west Africa.

He was a lifelong ardent admirer of W. E. Gladstone who described him as "a heaven-born Home Secretary"; yet Gladstone's first administration was much damaged by Bruce's policies. The trade union legislation of 1871 was contradictory and generally unpopular. Bruce, a sincere churchman, came to be regarded by both Anglicans and Dissenters as evasive in ecclesiastical matters. Above all. his regulation of liquor licensing in 1872, an attempted compromise on a controversial topic, contributed significantly to the defeat of the Liberals, "borne down in a torrent of gin and beer," at the general election of 1874. Now a liability to his party, Aberdare retired from politics. He died in London on Feb. 25, 1895. (A. F. T.)

ABERDARE (ABERDÂR), an urban district in the Aberdare parliamentary division of Glamorgan, Wales, at the confluence of the Dar and Cynon (the latter being a tributary of the Taff), 23 mi. N.N.W. of Cardiff by road. Pop. (1961) 39.044. Area 23 7 sq.mi. The neighbouring moorlands show evidence of occupation in pre-Roman times. The parish church of St. John the Baptist dates from the 12th century. Aberdare has a fine public park.

The town remained but a small nucleus among the scattered farms of the moorlands until the beginning of the 19th century when it grew rapidly because of the abundance of its coal and iron ore, and the population of the whole parish (which was 1.486 in 1801) increased tenfold during the first half of the century. Ironworks were established at Llwydcoed and Xbernant in 1799 and 1800 respectively, followed by others at Gadlys and Aberaman in 1827 and 1847. The building of the Glamorgan canal in 1811 connected these ironworks with the coast, but the railways superseded the canals and at the same time gave an impetus to the iron trade between 1820 and 1870. Previous to 1836 most of the coal mined in the parish was consumed locally, chiefly in the ironworks, but in that year the mining of steam coal for export was begun, pits were sunk in rapid succession and the coal trade, which at least since 1875 had been the chief support of the town, soon replaced the ironworks. Aberdare was severely affected by the depression of the 1930s. Some mines were abandoned, but others were modernized, while new fields and opencast sites were developed after 1945. There are several brickworks and breweries After World War II many light industries were established in the vicinity, especially at Hirwaun. Cables, metal tubes and washing machines are made and a patent smokeless fuel is produced. A college of further education was opened at Cwmdare in 1955.

ABERDEEN, GEORGE HAMILTON-GORDON, 4TH EARL OF (1784–1860), British statesman, who was prime minister of the coalition government in office at the outbreak of the Crimean War, was born at Edinburgh, Scot., on Jan. 28, 1784. His parents both died before he mas 12; his grandfather, the 3rd earl, who died in 1801. cared little for him and he was brought up by his guardians William Pitt and Henry Dundas (later Viscount Melville). He was educated at Harrow and St. John's college, Cambridge. He traveled in southern Europe and the Levant during 1802–04, and made useful excavations at Ephesus and Athens (hence Byron's reference to "The travell'd Thane! Athenian Aberdeen"). In 1805 he married Catherine, daughter of the 1st marquess of Abercorn; they were ideally happy together. but she died of consumption in 1812, and none of her children lived to come of age. He wore mourning for her for the rest of his life.

In 1813 Viscount Castlereagh, then foreign secretary, appointed him special ambassador to Austria. For nine months Aberdeen was one of the central figures in European diplomacy, helping to form and to hold together the coalition that crushed Napoleon's power. He signed the treaty of Toplitz (Sept. 1813), was present at the battle of Leipzig (October) and at the congress of Châtillon, and signed the treaty of Paris on May 30, 1814. Castlereagh, who thought him too lenient to the French, then took over all the principal negotiations himself, and Aberdeen retired. One of his brothers. Sir Alexander Gordon, aide-de-camp to the duke of Wellington, was killed at Waterloo. In July 1815 Aberdeen was remarried, to his first wife's sister-in-law Harriet, dowager viscountess Hamilton, who bore him five children and died in 1833.

Aberdeen devoted much time, thought and money to his large estates round Haddo house, Aberdeenshire; he planted numerous trees there. and greatly improved his tenants' conditions. In 1825 he persuaded parliament to pass the liberalizing Entail (Scotland) act. At Wellington's request, he became chancellor of the duchy of Lancaster in Jan. 1828, and in June took over the foreign secretaryship. He helped to settle the question of Greek independence, maintained neutrality in Portuguese affairs, and opposed France's designs on Algeria. Resigning in Kov. 1830. he did not again hold office for over a decade, except as secretary for war and the colonies in Sir Robert Peel's brief administration in 1834–35. Scottish church affairs much occupied him, and he strove without success to avert the disruption of 1843 (see SCOTLAND, CHURCH OF).

From Sept. 1841 to July 1846 he was again foreign secretary under Peel. The queen had confidence in him; his friendships with Metternich and Guizot. who became French foreign minister in Oct. 1840, and his pacific inclinations, helped him to do well. He established an effective entente with France, which survived a sharp quarrel over Tahiti in 1844, but not his own retirement. More importantly, he composed two long-standing boundary disputes with the United States, by the Webster-Ashburton treaty of 1842 and the Oregon treaty of 1846. He supported Peel in his corn law policy and resigned with him. On Peel's accidental death in 1850 he was acclaimed the leader of the Peelites.

They agreed with him in deploring Lord John Russell's Ecclesiastical Titles bill, introduced early in 1851, which forbade Roman Catholic bishops to use their territorial titles; but the measure was momentarily so popular that it prevented Aberdeen from accepting the queen's invitation to form a government on Russell's resignation that spring. In April he received Gladstone's ardent protests at the iniquities of the Bourbon regime in Naples, and took the matter up privately with Vienna; but the answer took so long to come that Gladstone published his *Letters* to him before it arrived, in July.

In Dec. 1852 Aberdeen succeeded in forming a coalition cabinet, composed of six Whigs, six Peelites and one Radical. The cabinet's harmony was almost entire, except for occasional notes of discord from Russell, who wanted to head it himself; and with Gladstone's celebrated first budget it had a successful year at home. Yet, during 1853, difficulties over the eastern question became so acute that war with Russia was unavoidable by the end of it. Public opinion in London forced war on a largely reluctant government. The prime minister, usually firm, upset Lord Clarendon, his foreign secretary, by vacillating. The two of them took a fatal step on Sept. 23; without consulting their colleagues, they ordered the fleet to Constantinople. The cabinet agreed, three months later, to send it into the Black sea; and the declaration of war that necessarily followed came in March 1854. At the time, Aberdeen could see no other step he could have taken; but in retrospect he felt himself responsible for the war. He never repaired a tumbledown church near Haddo; I Chronicles xxii, 7–8, David's account of his unwillingness to build the Temple, provided his reason. Aberdeen was ill-informed by the soldiers on the spot in the Crimea, but he was constitutionally responsible for their mistakes, and was driven from office by a strongly adverse vote of the commons in Jan. 1855. The queen created him a knight of the Garter on retirement. He lived on. an elder statesman and a Scottish patriarch, till his death in London on Dec. 14, 1860.

Though dour and stiff at first meeting, Aberdeen was a quick-witted man of great gentleness and sweetness of temper. Of singular uprightness and probity, he was almost too straightforward and naive to tackle the diplomats and politicians of his day. He was a sincere lover of peace; the cries of the wounded at Leipzig never ceased to ring in his ears.

Of his sons, the eldest, George John James (1816–64), became the 5th earl. and the youngest, Arthur (1829–1912), a successful

colonial governor, was created Lord Stanmore in 1893. His grandson, the 7th earl, was created marquess of Aberdeen and Temair in 1915.

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ABERDEEN, a royal burgh, city and county of a city and the capital of Aberdeenshire (*q.v.*), Scot., is situated on a bay of the North sea between the rivers Dee and Don, 130½ mi. N.E. of Edinburgh by rail and 118 mi. by road and ferry. Pop. (1961) 185,379. It is the third city in Scotland and the chief seaport of the north of Scotland.

The City.—Aberdeen (Gaelic *Aber*, "mouth"; *deen*, "of the Dee") is called "the Granite city" from the gray granite of which it is largely built and which, gleaming in the sunshine, justifies the other popular name of "the Silver City by the Sea." The old market place (Castlegate), lying at the base of the Castle hill (this recalls the castle, which was demolished in the 14th century), has been a focal point of the burgh's activities since earliest times. Nearby are the oldest streets, dating from the 13th and 14th centuries. Union street, the principal thoroughfare (nearly a mile long) and King street, which were constructed early in the 19th century, form with Holburn street a main artery, 5 mi. in length, linking the Dee with the Don.

In the Castlegate stands the market cross (1686), an open-arched hexagonal structure, considered to be the most handsome of old crosses in Scotland. In the neighbourhood are three 17th-century houses, Wallace tower, Provost Skene's house (now a museum of local history) and Provost Ross's house. Behind a dignified granite façade in Union street stand the twin churches of St. Nicholas (the West, and the North and East), which occupy a building that until 1596, when it was divided, was the old parish church dedicated to the burgh's patron saint. The oldest parts of the structure are the transepts, which separate the two churches, and a small vaulted chapel (St. Mary's) built about 1430. The steeple above the transepts houses a carillon of 48 bells, the largest in Great Britain. The existing West church dates from 1755 (a famous Aberdeen architect, James Gibbs, was the designer) and its neighbour from 1838 (the work of another eminent Aberdonian, Archibald Simpson). In Old Aberdeen stand two pre-Reformation structures. One is the cathedral of St. Machar, built, partly of granite, between c. 1366 and 1530. Its heraldic ceiling is an interesting feature. The other is the chapel of King's college with its stately Crown tower (1505). Within the chapel are exquisite examples of oak carving on stalls and choir screen, and there (as also in the cathedral) are to be seen beautiful stained-glass windows by Douglas Strachan, a native of the city. Two old bridges survive in Aberdeen: the Brig o' Balgownie, spanning the Don and built, it is said, by order of King Robert I about 1320; and the old Bridge of Dee, completed in 1527.

There are many handsome new granite buildings in the city, in both traditional and modern design. At the east end of Union street stand the imposing municipal buildings (with a main tower 200 ft. in height), which assumed their present form in 1868–74. In the charter room is a valuable collection of documents and relics. No other burgh in Scotland possesses so complete a record of its past. The council's records cover the burgh's activities from 1398 to date, with one break: vol. iii (1414–33) is missing. In Union street also are Trinity hall, the home since 1847 of the incorporated trades, the Music hall with a well-proportioned Grecian portico and, dominating the west end, Christ church (Divinity hall). In Broad street, on a site once occupied by Grey Friars: stands Marischal college, the largest granite building in Great Britain. Part of the existing structure was erected in 1844 (to the design of Archibald Simpson), and in 1893–1906 considerable alterations and additions were made, including a magnificent granite frontage (400 ft. in length) and the Mitchell hall with a lofty tower (235 ft.) named after the donor, an alumnus of the university. The Roman Catholic cathedral of St. Mary is in Huntly street. In an attractive setting in a residential district called Foresterhill are Aberdeen's main infirmary buildings, completed in 1936. The parks, recreational grounds and open spaces in the city total 2,185 ac.

History.—Aberdeen's recorded history goes back to the 12th century. The oldest extant charter is one granted by William the Lion (c. 1179) conferring trade privileges on the burgesses. The burgh supported Robert Bruce during his struggle for Scotland's freedom. By a charter dated 1319 he handed over to the burgesses (for a small yearly feu duty) the royal burgh itself and extensive lands adjoining it, but a large part of this valuable gift mas alienated in the 16th century. The burgh was burned by the English in 1336. In 1638 Charles I acknowledged the support given to his religious policy in Aberdeen by granting a "Great Charter" amply confirming the burgh's ancient rights. In the wars of the 17th century between royalists and parliamentarians Aberdeen suffered severely, particularly in an attack on the city in Sept. 1644 by the marquis of Montrose, fighting then on the king's side. In 1715 and again in 1745 the Jacobite pretender to the throne was proclaimed king by his adherents at the market cross, but while in 1715 there was displayed in the city a measure of enthusiasm for the Stewart cause this had waned 30 years later. From the early 19th century Aberdeen grew in size and importance, and in 1891 large adjoining areas, including the two burghs of Woodside and Old Aberdeen, were incorporated in it.

The history of Old Aberdeen is bound up with that of the cathedral. Legend tells that St. Machar, a disciple of St. Columba, was instructed to build a church in the northeast of Scotland at a spot where a river took the form of a shepherd's crook. Not far from the sea the Don river assumed such a form and, in a tiny hamlet nearby. the church of St. Machar was built. In the 12th century the status of this Christian settlement was radically altered when it became the seat of the bishopric of Aberdeen founded by David I. Thereafter the cathedral of St. Machar dominated the life of what in old documents was called Aberdon, but later became known as Old Aberdeen (or Aulton). Charters granted by James IV in 1489 and 1498 created it "a free Burgh of Barony for ever," with the church as its superior. The administrative control of the church continued till some time after the Reformation. Till 1891 Old Aberdeen had its own council, provost, trade guilds, etc. Recalling its former independence there remain the old town house and, nearby, a fragment of the market cross.

From early times Aberdeen was prominent in cultural and other achievements. It claims as its son Scotland's first poet, John Barbour (*q.v.*), author of *The Brus*. The earliest mention of a "play" in Scotland is to be found in Aberdeen's records—a performance of Haly *bluid* in 1440. George Jamesone (c. 1587–1644), the first Scottish painter of whom there is any record, was a native of the city. Among a large number of others whose fame spread far beyond their birthplace were Alexander Cruden (*q.v.*), author of the *Concordance* of *the* Holy *Scriptures* (1737), John Hill Burton (*q.v.*), the historian, William Dyce (*q.v.*), the painter, Mary Slessor (1848–1915), missionary in Africa, Sir George Reid (1841–1913), president of the Royal Scottish academy, and Sir Arthur Keith (*q.v.*), the anthropologist.

Education.—For more than 260 years there were two separate, autonomous universities in the northeast of Scotland within a mile of each other. Through the effortsof Bishop William Elphinstone (*q.v.*), Pope Alexander VI authorized, by a bull dated Feb. 10, 1494, the foundation of a university in Old Aberdeen, and King's college was built. From the beginning King's offered a course in medicine—the first recognition of this subject by a university in what was later to become Great Britain. The second university was Marischal college in the main burgh, founded in 1593 by George Keith, 5th earl marischal, as an essentially Protestant institution to offsetthe Catholicism that persisted at King's, which was under the influence of the stanch Roman Catholic, George, 6th earl of Huntly. From 1641 to 1661 King's and Marischal were united under the name of King Charles's university, but the union was merely formal (virtually no change took place in administration or policy) and it was not until 1860 that a complete union was effected. Other institutions of higher education are the Robert Gordon's technical college, the training college

for teachers and (just outside the city) the North of Scotland College of Agriculture. Research work is carried out by the Marine laboratory and Torry station (fisheries), the Macaulay institute (soil) and (near the city) the Rowett institute (animal nutrition).

Of secondary schools the oldest is the grammar school, founded as the medieval burgh school. It occupies a handsome building in Scottish baronial style, opened in 1863. In the front quadrangle stands a statue of Lord Byron, who was a pupil there for a time. The only other old school is Robert Gordon's college, opened in 1750 as a "hospital" for the maintenance and education of "sons or grandsons of decayed Burgesses of Guild" of Aberdeen. The founder was an Aberdeen trader, Robert Gordon, who left his fortune of £10,000 to endow the institution. In 1881 the old "hospital" came to an end, its place being taken by the college, primarily a day school.

Communications, Commerce and Industries. — Not only has Aberdeen a good harbour and, at Dyce, 6 mi. N.N.W., its own airport, but it is also an important junction for rail and road communications between north and south. It is in fact the commercial capital of a large part of northern Scotland and, with its rich agricultural hinterland, is one of Scotland's largest livestock-selling centres.

The estuary of the Dee formed Aberdeen's first natural harbour, which was gradually improved in the course of the years. The construction of the North pier (1,200 ft.) in 1780 (on the advice of John Smeaton), the extending of this in the following century (after consultation with Thomas Telford), the completion of the South breakwater in 1878, etc., lessened the hazards of the navigation channel, while the building of quays, docks and warehouses and the diversion of the Dee into a new bed vastly improved the harbour facilities. The harbour can accommodate vessels drawing up to 27 ft. of water and is well provided with modern equipment. A dock bridge, opened in 1953, is of interest since it was the first aluminum-alloy bascule bridge to be constructed in Scotland. The harbour estate, administered by a board of commissioners, extends to 370 ac., of which 199 ac. comprise the water area. One valuable asset is the fish market (nearly half a mile in length with an average width of 52 ft.), which was opened in 1889 and considerably enlarged and modernized in the late 1920s. The trade of the port is extensive and links Aberdeen not only with other ports in Great Britain but also with the mainland of Europe (particularly Scandinavian, Baltic and Mediterranean countries), North and South America, Australia, etc.

Aberdeen owes its importance as the premier fishing port of Scotland and the third in Great Britain to the development of the steam-trawling industry. This was started in 1882 but is now being superseded by diesel-trawling. Linked with the fishing industry are ancillary trades, such as curing and ice manufacture. In the 19th century Aberdeen became famous for the construction of fast tea clippers (the best-known was probably the "Thermopylae") and, since iron replaced wood, its shipyards have launched trawlers, cargo vessels and tugs.

Since the middle of the 18th century granite has been quarried in Aberdeen (Rubislaw quarry is the main source) and, with other quarries in Aberdeenshire furnishing a plentiful supply of the stone, the city has become the largest centre of granite working in the United Kingdom, providing not only building material but also monumental work, sets for road paving, etc. Other industries include textile manufacturing (wool and linen), papermaking, engineering, the making of agricultural implements, plastics, paint, chemicals and fertilizers. Aberdeen has also become a popular holiday resort and it is the depot of the Highland brigade.

Administration. — The city returns two members to parliament. For local government it is divided into 12 wards, each returning 3 members to the council, on which also sits the dean of guild. The chairman of the council (and civic head) is designated lord provost.

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ABERDEEN, a city of South Dakota, U.S., seat of Brown county, is located in the northeastern part of the state about 270 mi. W. by N. of Minneapolis, Minn. With more than 50 wholesale concerns in the city it is the financial and trading centre for a large wheat, corn, cattle and hog producing area extending into North Dakota.

Aberdeen's first settlers arrived in 1880 and the city, which was incorporated in 1882, has grown steadily since that time, exceeding 20,000 after mid-20th century. (For comparative population figures, see table in SOUTH DAKOTA: *Population*) The state's early settlers were, for the most part, young men from the wooded areas of the east and, in smaller numbers, Scandinavians, Germans and Russians.

Northern State Teachers college, a four-year liberal arts and teacher-training college, was founded in Aberdeen in 1901. The largest teacher-training college in the state, it had an enrollment of more than 1.000 after mid-20th century. Presentation junior college, a Catholic school for girls, was founded there in 1951.

(M. G. Co.)

ABERDEEN, the largest city in Grays Harbor county, Wash., U S., is located about 48 mi. W. of Olympia and Puget sound on the estuaries of the Chehalis. Wishkah and Hoquiam rivers which together make Grays harbour. It combines with its neighbouring communities of Hoquiam and Cosmopolis to form a single area of settlement.

Aberdeen is located just south of the wild areas of the Olympic peninsula and Olympic National park The recreation facilities in the Olympic mountains, the Quinault Indian reservation and the nearby ocean beaches bring visitors from every state in the union. The foggy climate and heavy rainfall on the western slopes of the Olympics to the north promote the growth of vast stands of cedar, hemlock and Douglas fir. Although fishing is an important resource, Aberdeen's basic industry has always been lumbering. Many of its inhabitants are descendants of Finnish and Swedish immigrants who came to the region to work in the lumber camps and mills.

The site of Aberdeen was first visited by Capt. Robert Gray who came on the "Columbia" May 7, 1792. Gray named the bay Bulfinch harbour. Samuel Benn, a Scottish immigrant, established a cannery there in 1878 and platted the townsite in 1883. The population reached a peak of about 20,000 in 1930 and remained constant for the next three decades while that of the rest of the state increased about 81%. (For comparative population figures *see* table in WASHINGTON: *Population.*) Aberdeen is the home of Grays Harbor college, founded in 1930. (K. A. M.)

ABERDEENSHIRE, the sixth largest county in Scotland with a land area of 1971.4 sq.mi., projects shoulderlike into the North sea, bounded on the west by Banffshire and Inverness-shire, on the south by Perthshire, Angus and Kincardineshire. Pop. (1961) 298.503.

Physical Features.—Although the county lies north of the Highland boundary fault, it consists essentially of an agricultural lowland drained by rivers which flow generally in an easterly direction. This low coastal plateau rarely rises more than 400–600 ft. above sea level except where it is surmounted by resistant rock formations such as the quartzites of the Hill of Mormond in the northeast of Buchan or the outliers of the Highlands. Elsenhere it is a rolling countryside, wind-swept and almost devoid of trees except in sheltered situations. The gentle slopes are mantled with glacial debris and dissected by the melt-water channels of the ice sheets which converged from the Grampians, the Moray firth and Strathmore. Marshy wastes, peat bogs, lochans

and infertile, often stony moorlands, penetrated by haughs or riverine lands along the Dee, Don, Deveron, Ugie and Ythan which were, and still are, liable to flooding, have been transformed by the plow and drainage to make the essentially agricultural landscape of today. Fertile raised beaches fringed with expanses of sand dunes alternate with magnificent cliffs cut in metamorphic and igneous rocks or Old Red Sandstone along the North sea and Moray firth to give an exposed coast broken only by small estuaries of which two, the Dee and Ythan, are navigable for a short distance inland.

The lonland of Buchan, and its southerly continuation in Formartine and Mar, terminates abruptly against the steep slopes of the Grampians (*q.v.*), which form a mountainous or upland rim to the west and south. From these heather-covered or cold stony wind-swept plateaus dissected by corries, which culminate in Ben Macdhui (4,296 ft) and other peaks such as Braeriach, fingers of the Highlands spread north and east back into the lowlands while the valleys of Dee and Don and their tributaries bring lonland conditions far into the highland zone. These cultivated glens, straths or wider basins, such as the Howe of Cromar, Strathbogie, the Howe of Alford and the Garioch, offer a sharp contrast nith the uninhabited peaty flat upland surfaces of the Hill of Fare, or the steep rocky slopes of Bennachie. Only at the southeastern and northwestern extremities is there easy connection with adjacent regions, although in the historical period the southern upland rim or Mounth was frequently crossed by glen and moorland routes which penetrate it from Strathmore in the south and from the Dee valley in the north.

The Old Red Sandstone rocks nhich probably once covered the whole area have been almost completely stripped away, except where preserved by down faulting. as in Strathbogie and in a belt between Turriff and the north coast, to reveal the underlying complex of igneous and metamorphic rocks. Although mainly composed of closely folded and faulted metamorphic rocks of the Dalradian series, with a Caledonian or north-northeast to south-southwest trend, the continuity is broken by masses of plutonic and hypabyssal intrusions, so that wide areas of gabbro and granite rocks occupy large parts of Aberdeenshire. These granites were formed both prior and subsequent to the folding of the main metamorphic rocks, and the Newer Granites such as the salmon pink variety from Peterhead, the gray of Aberdeen and the light-coloured rock from Kemnay have given rise to the important quarrying and polishing industries of the country. Over most of the loalands and in the highland valleys, the solid geology is effectively masked by the deposits of the ice streams which invaded the district from the Cairngorms, the Moray firth and Strathmore, the latter leaving a characteristic belt of red clays and moraines aith marginal channels along the coast as far north as Peterhead, covered in places by deposits of the valley glacier of the Dee. The salmon- and trout-bearing Dee, Don and other rivers have been diverted in many places, while lochs have been impounded by moraines as at Loch Kinord and Loch Davan on the Muir of Dinnet on Deeside.

Situated on the east of Scotland in the rain shadow of the Grampians, the climate of Aberdeenshire is generally dry with parts of the coastal strip receiving less than 25 in. of rain annually, but cold sea mists occasionally cover a narrow belt along the littoral and penetrate farther inland along the river valleys. Temperatures are warm for the latitude but exposure to cold winds from the north and east gives a somewhat harsh winter climate. High-level hill roads have been blocked with snow in June.

The subalpine vegetation on the highest summits and plateaus gives way at lower levels to heather moors. nhich are found also on the unreclaimed sections of the loalands and on the older dunes along the coast. Elsewhere the natural vegetation of the lowlands has been modified by cultivation, except, for instance, on the sandy outaash deposits of the Dee valley nhich are still under forest. The fauna ranges from the eider ducks and waders of the nature reserve of Forvie, at the mouth of the muddy Ythan estuary, to the deer, mountain hares, golden eagles, grouse and snow buntings of the high Cairngorms. On the lowlands the development of agriculture has encouraged the grouth of a vegetarian population, including hares and rabbits. (K. W.)

History.—some of the coastal stretches of the county and parts of lower Deeside have been occupied since Mesolithic times. One or two long cairns of the Neolithic period survive; but the effective colonization of the area dates from the settlement of the Beaker folk, coming direct from Holland at the commencement of the Bronze Age, about 2000–1800 B.C. To the latter part of this period belong the stone circles and round cairns in which the shire is so rich. A special type of stone circle, marked by a recumbent stone in the southwestern sector, is almost restricted to the area between Dee and Spey. The Iron Age is represented by numerous earth houses and a group of massive stone hill-forts—two of which, on Dunnideer and Tap o' Noth, are vitrified. At the dawn of history the county was occupied by Celtic tribes whom Ptolemy called Taixali. Later, Aberdeenshire formed part of the territories of the Northern Picts. Roman marching camps exist at Culter, Kintore and Ythan Wells. Christianity was introduced at an early period. and there were Celtic monasteries at various places, notably Old Deer and Monymusk. Early Christian sculptured stones of high artistic merit, many showing the mysterious Pictish symbolism, abound. Though the coast was exposed to Viking raids, definite traces of Scandinavian colonization are lacking; but with the advent of Anglo-Norman feudalism, sponsored by the Canmore dynasty, colonies of Flemings were introduced, by whom the wool trade was developed. Royal burghs were built at Aberdeen, Kintore and Inverurie, and were peopled mainly by English settlers. The great Celtic mormaorships of Mar and Buchan were in due course transformed into feudal earldoms (see MAR, EARLDOM OF; BUCHAN, EARLS OF). Gradually the old Celtic tongue became restricted to the upper parts of Deeside and Donside, and in the 20th century it became extinct in the county.

Aberdeenshire played its part in the long struggle between the rival houses of Canmore and Macbeth. It was at Lumphanan on Deeside that Macbeth (*q.v.*) fell in 1057, and his stepson Lulach, who continued the struggle, nas killed next year at Essie in Strathbogie During the Anglo-Norman penetration great families such as the Balliols, the Bruces and the Comyns obtained a footing in the shire. When the contested succession between these three houses resulted in the Scottish War of Independence, Edward I twice traversed the county, in 1296 and 1303; and a famous event was the heroic defence of Kildrummy castle in 1306. Robert Bruce's victory next year near Inverurie may be regarded as a turning point in the struggle, and was followed by the savage hership or wasting of the Comyn earldom of Buchan (see ROBERT I, "THE BRUCE"). Another turning point was the victory of the nationalists at Culblean on Deeside in 1335. The triumph of Bruce resulted in the settlement of new families, among whom the Forbeses and the Gordons emerged as the principal rivals in the period of feudal strife during the 14th and 15th centuries. A deep mark was left upbn the memory of after generations by the bloody battle of Harlaw (1411), in which Donald, lord of the Isles, seeking to enforce his claim to the earldom of Ross against the earl of Buchan, was defeated by Alexander Stewart, earl of Mar. Sir Alexander Forbes and Sir Alexander Seton of Gordon were created Baron Forbes and earl of Huntly respectively in 1445; and the struggle for power between these two families fills up the history of the next two centuries Its bitterness was intensified by the fact that, in the main, the Forbeses accepted the Reformation, ahile the Gordons adhered to the ancient faith. Huntly castle, the chief seat of the Gordons, became in effect the Scottish headquarters of the counter-Reformation. A notable event in the struggle was the victory of the royal forces over the earl of Huntly at Corrichie on the Hill of Fare (1562) (see GORDON; HUNTLY [EARLS AND MARQUESSES OF]). During the Civil War of the 17th century Aberdeenshire emerged as a stronghold of royalism and episcopacy. The very first action of that uar mas known as the Trot of Turriff (1639). Inevitably the county was the scene of much fighting, notably the marquess of Montrose's victories in the royal cause at Aberdeen and Fyvie (1644) and Alford (1645) Aberdeenshire also witnessed some of the most agile marches and countermarches of John Graham of Claverhousr and Hugh hlackay during the Jacobite rising of 1689.

Meanwhile, trade with the low countiies, the Hanseatic league, Prussia and Poland had flourished, and in the 17th century this laid the foundations of a new wealth among some of the ancient county families. The progress of learning is marked by the founding of three universities—King's college in Old Aberdeen (1494), Marischal college in the new town (1593) and the short-lived University of Fraserburgh (1597). The episcopacy of the northeast, more favourable to culture than was Calvinism, reached its fine flowering in the celebrated school of scholars known as the "Aberdeen ,Doctors"—scattered by the "club law" of the Covenant.

From 1690, after the Revolution settlement, more tranquil conditions prevailed. Yet local devotion to Jacobitism and episcopacy persisted and found vent in the risings of 1715 and 1745. It was at Braemar (*q.v.*) that the Stewart standard uas raised in 1715, and later in that year James, the Old Pretender, landed at Peterhead. A brisk event in the 1745 rebellion was the Jacobite victory at Inverurie. Upon the collapse of this rebellion the penal laws destroyed the ascendancy of episcopalianism and the feudal power of the landowners, and paved the way for the ensuing era of agricultural and industrial progress.

The castles of Aberdeenshire range from Norman earthworks, like the Bass of Inverurie, the Peel of Lumphanan and the Doune of Invernochty, through the splendid royal stronghold of Kildrummy, to such fine Renaissance buildings as Huntly, Craigievar, Castle Fraser and Fyvie. Ecclesiastical architecture includes the Norman church of Monymusk and the remains of the Cistercian abbey of Deer. There are fine 16th-century sacrament houses, of a type peculiar to the northeast, at Kintore, Kinkell and Auchindoir. (W. D. S.)

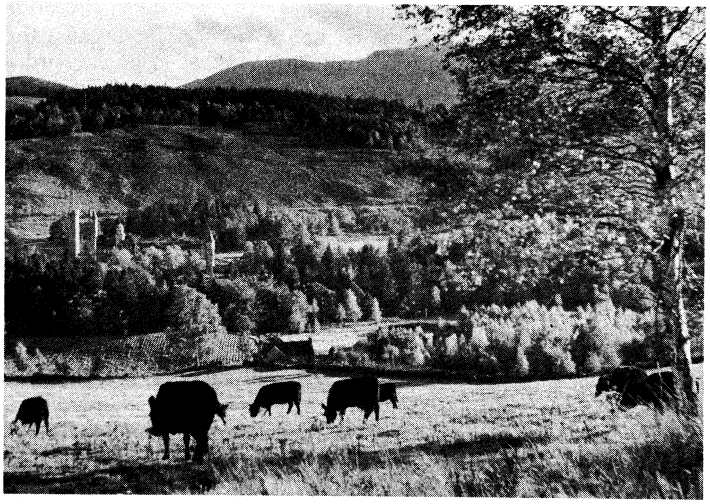
Population and Administration.— The population in 1961 was 298.503, of whom 161,125 were in the Aberdeenshire portion of the city of Aberdeen (the small portion of the city south of the Dee is, for census purposes only, in Kincardineshlre). The figures for the county were the lowest at any census since 1851 because of continued rural depopulation. The bulk of the rural population is found on the lowlands, where the larger towns such as Peterhead (12,497), Fraserburgh (10,462), Inverurie (5,152), Huntly (3,952) and Turriff (2,686) (*qq.v.*) are also situated. The supreme court of justiciary sits in Aberdeen to try cases from the counties of Aberdeen, Banff and Kincardine, while Aberdeenshire and Kincardineshire together return three members to parliament.

Agriculture, Industries and Communications.— The favourable environment of the lowlands has been intensively exploited since the re-organization of the economy and agricultural techniques which nas completed by about 1850. Emphasis was laid on the rearing of beef cattle, especially the famous Aberdeen Angus (see CATTLE), in association with arable farming to provide fodder. with sheep also important in both highland and lowland areas. The cattle industry gathered momentum as communications with London and the industrial markets improved. Oats are the predominant crop, with turnips, swedes, potatoes, barley and sown grasses on the remaining cultivated acreage, which extends to an altitude of about 800 ft., varying locally nith the degree of exposure. Dairying and pig and poultry keeping are increasing in importance with the establishment of a surplus milk conversion unit, a bacon factory and egg-grading stations. About tno-thirds of the population depend on farming, practised principally on small farms and crofts, while the fishing industry is the second most important occupation.

The steam tranler, nhich caused the eclipse of numerous small fishing ports and gave the county town of Aberdeen pre-eminence as the Scottish centre for trawling and great-line fishing, making it the chief port for white fish, is itself on the decline. Its place is being taken by diesel trawlers which, although fewer in number, are much more efficient. Fresh fish is taken increasingly to the southern markets by road rather than by rail, while new techniques, such as fish freezing at the port, are being intensively employed. Fraserburgh and Peterhead, formerly most important as seasonal herring ports, now give increasing attention to white fishing using dual-purpose seine-net vessels. Stake nets for salmon fishing are found along many sections of the coast.

Auxiliary industries such as boxmaking, curing and kippering are important in each of the fishing ports and the food- and fish-canning factory at Peterhead is of especial interest. Shipbuilding is prominent in Aberdeen, where large coastal, ocean-going and fishing vessels are built, while smaller, principally wooden, fishing vessels are produced at Peterhead and Fraserburgh.

Although there are precision industries at Peterhead and Fraserburgh, where twist drills and pneumatic tools, respectively, are manufactured and give much-needed diversification of employment, industry is concentrated principally in Aberdeen and its vicinity and steps are being taken to increase industrial employment there. Papermaking is important along the lower reaches of the Don, newsprint and high-quality papers being produced from imported pulp, esparto grass and rags. Granite working, using local and imported stone, is concentrated in many small yards where monumental polished masonry, granite facings and blocks for constructional work are prepared. Engineering workshops. linen- and canvas-weaving factories, and paint, chemical and fertilizer industries are also found in Aberdeen, which acts as a market and distributing centre for most of the north of Scotland. Elsewhere in the county industries include distilling and forestry and a railway repair workshop at Inverurie.



J. ALLAN CASH

PASTURE LAND OF UPPER DEESIDE. ABERDEENSHIRE. WITH BALMORAL CASTLE IN THE BACKGROUND

The attractions of the coastal and mountain scenery bring increasing numbers of tourists while the association of the royal family with Balmoral castle (*q.v.*) and upper Deeside is well known. Winter sports in the Cairngorms are being encouraged by the construction of ski tows and huts, and hotels which formerly closed in the winter now remain open all the year round.

Guided by the relief features, the main road and rail communications enter the county at the southeastern and northwestern corners. and although there are roads through and over the mountain rim these are liable to be blocked by snow in the winter. Some local railway lines have been closed, but a system of bus routes connects rural districts with their market centres and with Aberdeen. Air services from Dyce airport near Aberdeen connect with all parts of the United Kingdom, including the Shetland and Orkney islands, while regular steamer services for passengers, freight and livestock operate from Aberdeen to the northern isles and the southern ports.

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ABERDOVEY (ABERDYFI, "mouth of the Dovey"), a small seaside tonn on the north side of the Dovey estuary, Merionethshire, Wales, lies 28 mi. N. of Aberystwyth. Pop. (1931) 1,262.

Its site has associations in Welsh folklore with coastal submergence (see CARDIGANSHIRE), and the song and legend of "The Bells of Aberdovey" are supposed to commemorate the inundation of the Lowland Hundred or Cantre'r Gwaelod (c. 520). During the 17th, 18th and 19th centuries Aberdovey had a considerable coasting and fishing trade and subsequently became a popular resort, because of its mild climate and pleasant scenery. It has a beach of firm sand which affords safe bathing, and there are excellent facilities for boating, fishing, golfing and rough shooting. The first Outward Bound Sea school for boys was established there in 1941.

ABERGAVENNY, a municipal borough and market town of Monmouthshire, Eng., lies at the confluence of the Gavenny with the Usk, 15 mi. W. of Monmouth and 19 mi. W.N.W. of Merthyr Tydfil by road. Pop. (1961) 9,625. Area 3.7 sq.mi. Situated at the entrance of the pass between the Black mountains and the Brecon beacons, it is a popular tourist centre and a nodal point for roads joining England and Wales. It also lies on the main Newport-Hereford railway line.

Abergavenny (*Aber,* "mouth of river") was the Roman Gobannium, a legionary fortress guarding the road up the Usk. It grew under the Norman lords of Abergavenny and there are remains of its medieval walls and of the 11th-century castle built by Hamelin de Ballon or Baludin. He also founded the Benedictine mitred priory of St. Mary, the chapel of mhich later became the parish church. The town was frequently embroiled in the border warfare of the 12th and 13th centuries and was burned by Owen Glendower in 1404. At the dissolution of the priory part of its endowment went toward a free grammar school, founded in 1542, when the town received its first royal charter. Abergavenny showed strong royalist tendencies during the Civil War, when it suffered badly at the hands of Thomas Fairfax (1646), and in 1689 it lost its charter because of its Jacobite sympathies. The market was of consequence as early as 1200, but with the better roads and greater movement of the 18th and 19th centuries cattle and horse fairs became more important. Today trade is still largely agricultural, the cattle market being one of the largest in the south Wales area. In the 18th century Abergavenny was famous for its wigs and Welsh flannel; its present industries include iron founding, printing and the manufacture of machines and sweets (candies). Abergavenny was reincorporated in 1899 and its boundaries were extended in 1935.

ABERRATION (OF LIGHT). This is an astronomical phenomenon depending on the fact that light is not propagated instantaneously. Observations of the heavenly bodies are made from the earth, a planet whose speed of motion is not incomparably smaller than that of light; the result is that the apparent position of a star in the sky does not correspond to its true direction from the earth. It is customary to assume intuitively that a body is "where it is seen to be"; or, since the distance cannot always be judged, that at any rate it is in the direction in which it is seen. But actually vision gives only an indirect acquaintance with its position. That which affects the observer's eyes is the light which has traveled to him from the object; the circumstances of propagation of the light must therefore be taken into consideration. It is well known that a light ray changes direction in passing from one transparent medium to another. *e.g.,* water to air, and that its course is curved in a medium of varying density such as the earth's atmosphere; an object seen by these dislocated or curved rays is displaced from its correct position, and the corresponding correction for refraction by the earth's atmosphere is highly important in determining the positions of stars. The correction for aberration is also concerned with the propagation of light; it arises from the fact that an observer's actual judgment of the direction of a ray involves a combination of the earth's motion and the motion of the light.

The most elementary explanation can be given in terms of the old corpuscular theory of light—which was the theory accepted at the time aberration was discovered. If the ray of light be thought of as a stream of missiles proceeding from the star with a speed of 156,000 mi. per second. it is clear that the apparent direction from which the missiles come will be affected by the earth's own velocity if that is not too insignificant in comparison. A common illustration is that of a man walking through a rainstorm with the drops falling vertically; the faster he walks, the more inclined is the position in which he must hold his umbrella to shield off the "missiles." The argument can be restated in terms of the wave theory of light without essential alteration; but reference should be made to an account of that theory for an explanation of the signification of "rays of light."

A rough way of aligning the direction of a star is to point a long, narrow tube so that the star can be seen through it. The alignment is given by the two apertures at the ends of the tube, which must be such that the small pencil of rays admitted through the one can make an exit through the other and thus reach the observer's eye (see diagram). The upper part of the diagram shows the raps of light coming from a star; the upper aperture E admits a narrow beam which continues in the original direction. so that F is the position in mhich the exit aperture has to be placed. Suppose that while the light travels the distance EF the earth moves through a distance GF; then the required direction of the tube is GE. It will then admit the light at E, and, by the time the light has traveled down the tube, the lower aperture will have reached the position F and the light will pass out. It will be seen that the tube GE does not point in the true direction of the star FE. The same principle applies when the tube is furnished with lenses, as in a telescope.

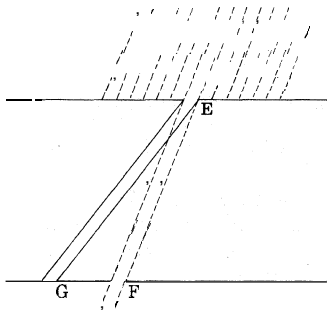
The alignment is the same whether the tube is long or short, and the relative proportions can be appreciated conveniently if EF is taken to be 186,000 mi. The light then takes 1 second to pass from E to F; and in 1 second the earth travels in its orbit $18\frac{1}{2}$ mi., represented by GF. Thus GF is $\frac{1}{10,000}$ of EF. The greatest possible angle between the observed direction and the true direction is $\frac{1}{10\,000}$ of a radian, or more accurately 20.49"; this is called the constant of aberration. (For comparison the apparent radius of Jupiter is about 20″; so that [when the aberration is at maximum] the observer sees the centre of Jupiter when actually looking toward the edge of its disk.) As the direction of the earth's motion changes throughout the year so the direction of the aberration displacement of a star changes; the star is always displaced toward the "apex of the earth's way," *i.e.,* the point of the sky toward which the earth's motion is directed, which is a point on the ecliptic 90° behind the sun in longitude. The star apparently moves in an ellipse around its true position as centre, making a circuit once a year. For a star at the pole of the ecliptic this ellipse is a circle of radius 20.49"; for other parts of the sky the path may be regarded as a parallel circle which is projected into an ellipse by foreshortening. The major axis of the ellipse is always 40.94″, but the minor axis depends on the latitude (*i.e.,* distance from ecliptic) of the star.

Discovery of Aberration. — The discovery of the aberration of light in 1725 by James Bradley (1693–1762) is one of the most important in the whole domain of astronomy; and in pure physics it has provoked a succession of investigations culminating in the theory of relativity. It was entirely unexpected, and it was only by extraordinary perseverance and perspicuity that Bradley was able to explain the phenomenon in 1729 The discovery arose in the course of an attempt to discover whether the stars had appreciable parallaxes The first authentic parallax was not measured until a century later, and it is now known that stellar parallaxes are less than a second of arc. Many observers had, however, claimed to have discovered such parallaxes. In 1680 Jean Picard in his Voyage *d'Uraniborg* stated, as the result of ten years' observations, that the pole star exhibited variations of position amounting to 40" annually; some astronomers endeavoured to explain this by parallax, but the motion was at variance with that mhich parallax would occasion. John Flamsteed, from measurements in 1689 and succeeding years with his mural quadrant, concluded that the declination of the pole star was 40″ less in March than in September. Robert Hooke in 1674 concluded from his observations that γ Draconis was 23″ more northerly in July than in October.

When James Bradley and Samuel Molyneux entered this area of astronomical research in 1725 there was much uncertainty as to whether genuine stellar parallaxes had been detected or not; and

it was with the intention of answering this question definitely that they erected a large telescope in Molyneux's house at Kern. They determined to reinvestigate y Draconis, a star selected because it passed almost through the zenith in the latitude of London; its position would not therefore be affected by troublesome and uncertain corrections for refraction. The telescope constructed by George Graham (1673–1751), a celebrated instrument maker, mas affixed to a vertical chimney stack; the eyepiece could be rnoved a little laterally by means of a screw so as to measure deviation from the vertical, which was fixed by a plumb line. The first observations were made on Dec. 3. 5, 11, and 12, 1725. On Dec. 17 Bradley found the star to be moving southward and confirmed this on Dec. 20. (The change of position in the north-south direction through aberratiop at this time of the year is rapid. and amounts to about 3.2" in ten days.) y Draconis was found to continue its southerly course until March when it was about 20" south of the December position. By the middle of April it was apparent that it was returning north again. In September it reached its northerly limit, the extreme range between March and September being 40".

Although the observers were seeking an apparent shift of the star, they immediately realized that what they had found could not be attributed to parallax. The maximum range of parallactic shift for γ Draconis should be between June and December. Aberration and parallax are easily distinguished by this three months' difference of phase; the displacement of a star due to aberration is always at right angles to that due to parallax. Bradley and hfolyneux discussed several hypotheses in the hope of arriving at an explanation. One hypothesis was that the direction of the earth's axis and therefore of the plumb line varied, causing an apparent displacement of the star when its position was measured with respect to the plumb line. Observations were therefore made of another star on the opposite side of the pole; from a comparison of its displacements with those of y Draconis it was found that they could not be explained by a shift of the earth's axis. (The precaution. however, mas fruitful, for by long-continued observation Bradley ultimately established that shifts due to a change of the earth's axis actually occurred; and he was led to his second famous discovery — nutation.) Bradley realized that observations of many more stars were required in order to determine the laws governing this mysterious effect of aberration. He therefore set up a more convenient telescope at the rectory at Wanstead, the residence of the widow of his uncle, James Pound, who had guided him in his early astronomical work. This telescope, erected in Aug. 1727, had a range of $6\frac{1}{4}°$ on each side of the zenith and thus covered a much larger area of the sky than the Kew instrument. Fifty stars were kept under close observation. Bradley disentangled from these observations the conclusion that a star had its extreme declinations at the times of the year when it passed through the zenith at 6 A.M. or 6 P.M.



DETERMINING THE DIRECTION OF LIGHT FROM A STAR (*see* TEXT)

The true theory of aberration was discovered by an accident reminiscent of the more apochryphal story of Newton and the apple tree. Sailing on the Thames, Bradley noticed the shifting of the vane on the mast as the boat altered its course; the shift was not due to unsteadiness of the wind but to the combining of the changing motion of the boat with the steady velocity of the wind. This suggested that the changing direction of the light rsy from the star was the result of the combination of the changing motion of the earth with the steady velocity of the starlight. The finite velocity of light had been discovered by the Danish astronomer Ole Roemer 50 years earlier: Bradley's discovery enabled him to give a greatly improved value for this velocity.

Astronomical Effects. — In modern astronomy the aberration due to the earth's orbital motion is included along with precession and nutation as part of the "star correction" applied to reduce from apparent to mean place. A small correction is also applied for diurnal aberration arising from the niotion of the observer caused by the diurnal rotation of the earth. For planets and comets a different procedure is adopted. It must be remembered that, even after allowing for the aberration, the body is seen not where it is now but where it was when the light left it (see fig.). Thus the corrected direction FE joins the position of the earth at the instant of observation of a planet to the position of the planet some minutes or hours before. Using the figure with a new connotation) let E be the planet when the light left it, and let F be the position of the earth when the light arrives. While the light travels from E to F the earth travels from G to F, so that the apparent direction of the planet GE is the actual direction joining the positions of the earth and planet at the time when the light left the planet. Accordingly there is no need to trouble about the hybrid direction FE. GE is accepted uncorrected, but a correction is applied to the time of observation, antedating it by the light time. This simple procedure is inapplicable to the stars whose light time is many years, because it assumes that the earth's velocity has been constant throughout the interval. But it answers a question often raised — whether a correction ought not to be applied on account of the aberration due to the motion of the whole solar system through space toward a point in the constellation Hercules. This motion, being uniform, admits of the above treatment; and the answer is that no correction is required provided it is understood that the observation relates to the state of things when the light left the star; the aberration rather helpfully "puts back the sun" to the earlier date which must in any case pertain to the star.

Since the velocity of light is known with great accuracy the observed value of the constant of aberration determines the earth's orbital velocity. This can also be calculated: when the radius of the earth's orbit is known. from observations of the solar parallax. There has long been a rivalry between the constant of aberration and the solar parallax as to which shall provide the more accurate determination; at present the degrees of accuracy seem to be about equal, and the two methods are in satisfactory accord.

Aberration, Ether and Relativity. — In the explanation of aberration. light was pictured as traveling in a straight line from the star uninfluenced by the motion of the earth carrying the observer. In the 19th-century picture of light as a wave train through a rarefied medium called the "ether," this would riot be true if the ether in the earth's neighbourhood were carried along with it; for when the light reaches this moving region of the ether its course will be disturbed, the motion of the ether (if the phrase has any literal meaning) being superposed on the ordinary velocity of the light traversing it. According to the modern idea of the atom introduced by Ernest Rutherford (later Lord Rutherford) in 1911, the electrons and atomic nuclei are so minute that the ether can slip through the void interior of the atom as easily as through the solar system, and there is no longer any reason to anticipate a con ection; but in the 19th century it seemed almost contrary to reason to imagine solid matter pushing its way through the etherial medium without serious disturbance. Apart from this prejudice, experimental evidence in the 19th century suggested that the ether in the lower part of the atmosphere was traveling with the earth, and, further, that moving matter such as a stream of water partially dragged the ether with it. Thus in 1818 the French scientist François Arago pointed out that the refraction by a prism (depending on the ratio of the velocities of light i n air and glass) ought to be altered by the motion of the prism through the ether; since no such alteration was observed he concluded that the surrounding ether shared the motion of the prism. His coworker A. J. Fresnel explained this effect by a "dragging coefficient," his hypothesis being that the "condensed" ether carrying the light inside the prism did not have the full motion of the prism but was only partially dragged in the same direction. This was apparently verified by A. H. L. Fizeau in 1851; he sent light in opposite directions around a circulating stream of water and thus studied its velocity with and against the current. In 1871 Sir George Airy performed his water-telescope experiment (originally

suggested by the Italian Jesuit physicist Ruggiero Giuseppe Boscovich), in which he measured the constant of aberration with a telescope that had its tube filled with water. According to crude reasoning, the aberration should have been increased, since the velocity of light is less in water than in air; but the normal value was obtained. Fresnel had already predicted that there would be a compensation when account was taken of the alteration of refraction at the surface of the moving liquid.

When Fresnel's theory was taken into account, the conclusion seemed to emerge that the ether-drag was limited to the interior of the moving bodies, and that its effects were compensated by changes of refraction at the surface of the bodies, except when (as in Fizeau's experiment) differential motions were concerned. Thus the ether just outside the solid earth would be stagnant as the theory of aberration requires. But in 1887 the American physicists A. A. Michelson and E. W. Morley made a much more delicate attempt to detect the difference of velocity of the earth and surrounding ether *(see* RELATIVITY: *Special Theory of Relativity)*; this seemed to decide that the ether was carried with the earth. Thus the conflict between stagnant and convected ether was brought to a head, the former being demanded by astronomical aberration and the latter by the Michelson-Morley experiment and certain later experiments involving similar principles. A reconciliation was ultimately effected by the theoretical investigations of the Dutch physicist H. A. Lorentz and Sir Joseph Larmor. Their work showed that the electrical structure of matter involves an alteration of length of all material objects in the direction of their velocity through the ether, which would compensate the effect looked for in the Michelson-Morley experiment — confirming a suggestion originally made by George FitzGerald. When allowance is made for this contraction, none of the numerous experiments are capable of testing the relative motion of the earth and ether. The position just prior to 1905 could be summed up as follows: The earth moves through the stagnant ether without disturbing it, as the original explanation of astronomical aberration demands. The objection that bodies carried on the earth show no effects of this relative motion is of no value because in all experiments the effects are precisely compensated.

A more radical view of aberration — eliminating the ether from physical theory altogether — was put forward by Albert Einstein in 1905 in the special theory of relativity *(see* RELATIVITY: *Special Theory of Relativity)*, which asserts that the laws of nature, and the value of the speed of light in a vacuum, are the same for all observers in uniform relative motion. Einstein deduced from this that two such observers would measure slightly different time intervals and spatial distances along the direction of their relative motion, and that these time intervals and distances would be related by the Lorentz transformation. In the same paper, Einstein gave the relativistic theory of aberration, which leads to the same formula as the older theory provided that the velocities involved are much smaller than that of light; but with the essential difference from the older theory that only relative motions between observers are involved. The two observers in this case are terrestrial astronomers measuring the angular position of a particular star from the earth at two different points of the latter's annual orbit around the sun; the measured position of the star undergoes a shift in the direction of the relative motion between the terrestrial observers at different times of year. The resulting annual change in the star's apparent position in the sky is of exactly the same character, and for practical purposes of the same amount, as is given by the classical explanation discovered by Bradley. However, the change in direction is due to fundamental relationships between distances and times measured by observers in mutual relative motion, and is thus virtually unaffected by the presence of small local amounts of refracting material; *e.g.*, in Airy's water-filled telescope.

The constant relative motion between the solar system and individual stars naturally leads to no observable change in any angular position in relativity theory. However, an important effect still does arise when very high velocities are involved (as in the case of remote galaxies). Aberration necessitates a correction to the apparent brightnesses of the galaxies, because the angle subtended at the source of light by the light-receiving surface (such as the observer's eye or a telescope) appears smaller to an observer moving with the source than to one stationed on the earth; without this correction, the intrinsic brightness of a rapidly receding light source would be underestimated.

At the present time, the special theory of relativity has received such abundant confirmation from laboratory experiments that there is no longer any doubt that aberration is due to relative velocity, or rather to the differences in the earth's velocity at different times of year. According to current ideas, there is no all-pervading physical medium, such as the ether, which would transmit light rays at a certain velocity and thus make uniform motion through the medium detectable. In this connection it is of some interest to note that astronomical observations have shown that aberration is equal for observatories at sea level and at the tops of mountains, contrary to what could be expected if there were an ether which was, in addition, dragged along at the earth's surface, but was stagnant at greater heights. However, laboratory experiments showing the validity of the Lorentz transformation for the masses and lifetimes of atomic particles now provide much more accurate and detailed verifications of special relativity than the above astronomical observations.

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(A. S. E.; B. E. J.P.)

ABERRATION IN OPTICAL SYSTEMS, the deviation of light rays from certain points through which they should pass in order to satisfy the conditions necessary for distinct focus. Spherical aberration results in distortion of the image, and chromatic aberration produces coloured fringes around an otherwise white image. *See* OPTICS; MICROSCOPE: *Simple Microscope.*

ABERTILLERY, an urban district in the Abertillery parliamentary division of Monmouthshire, Eng.. 22 mi. N.N.E. of Cardiff by road. Pop. (1951) 27.620. Area 10.1 sq.mi. It is a coal-mining town, with five collieries in the area, lying in the Ebbw Fach valley that runs south to Newport between two spurs of mountains. Formerly known for its stone quarries, it developed rapidly after the middle of the 19th century, the first coal mine being sunk at Cwmtillery about 1850, at which time the tin-plate works were already established.

Following the depression of the 1930s, a joint industrial development committee with the neighbouring towns of Brynmawr (Brecon), Nantyglo and Blaina (Monmouthshire) was formed and many factories were built in the valley.

ABERT RIM, a striking rock formation in south central Oregon, U.S., is one of the largest fault scarps in the world. *(See* also FAULT.) The rim runs along the eastern edge of Abert lake for 19 mi., rising about 2,000 ft. above the lake, and has an 800-ft. lava cap ending in a sheer precipice.

Lieut. John Charles Frémont and his men discovered Abert rim and lake in Dec. 1843. Legend says that a party of Indians chased a wagon train of white people across the level plateau which slopes gradually from the east up to the summit of the rim, and drove them over the cliff. In the vicinity of Abert lake are found crude pictographs on rocks, rock foundations of dwellings of prehistoric people, arrowheads and skeletons.

Rhinoceros and camel fossil remains and those of many other animals have been found nearby.

ABERYSTWYTH, a municipal borough, seaside resort, university town and the county town of Cardiganshire, Wales: in the Cardigan parliamentary division. It stands on the shores of Cardigan bay, backed by hills, at the mouth of the artificially united Rheidol and Ystwyth rivers, 111 mi. N.N.W. of Cardiff by road. Pop. (1961) 10.318. Area 1.8 sq.mi. On Pen Dinas hill, south of the town, is one of the largest hilltop earthworks in central Wales. With the clearing of the lowland, Pen Dinas was superseded by Llanbadarn Fawr. Castell Aberystwyth—the most interesting of three Norman motte and bailey castles in the neighbourhood — stands above the bend of the Ystwyth and gave its name (*Aber,*

"mouth of river") to the stone castle built about 1277–89 near the fishing village that grew up at the river mouths. The history of the castle was a troublesome one. It was finally captured by the English in 1407–08 and during the Civil War a mint was established there which was moved to Shrewsbury in 1642. In 1646 the castle surrendered to the parliamentarians and was destroyed. Restoration work was done on it in the 20th century. After about 1555 the fishing village of Llanbader was called Aberystwyth. Traces of the medieval town walls are still to be seen.

Aberystwyth shared in the mining (lead), agricultural and sea trade movements of the early 19th century and seems to have become at this time the social centre for the surrounding area. It has since gained favour as a summer holiday resort with its wide beaches of sand and shingle. The coming of the railways killed the coastal trade and the harbour is now little used. There are boatbuilding, brewing and mineral water works and the town is the centre for a large agricultural district. There is a plant-breeding station there. Aberystwyth became the site of the founder college of the University of Wales, founded in 1872 and incorporated by charter in 1889. and of the National Library of Wales. begun in 1911 and completed in 1955. The library. standing on a hill, has more than 1,000,000 books and thousands of manuscripts. In 1906 the Theological College of the Presbyterian Church of Wales was moved there from Trefecca.

Aberystmyth, whose first charter was granted in 1277, was incorporated in 1877. The Michaelmas fair (now called the November fair) and the Monday market (now for cattle), granted by the first charter. are still held.

ABETTOR, a law term implying one who is present, actually or constructively, and aids and abets another to commit an offense. An abettor differs from an accessory (*q.v.*) in that he must be present at the commission of the crime; all abettors (with certain exceptions) are principals in the second degree, and, in the absence of specific statutory provisions to the contrary, are punishable to the same extent as the actual perpetrator of the offense. *See* CRIMINAL LAW.

ABEYANCE, in law, is a state of expectancy with respect to property or title when ascertainment of the owner of a right must await the happening of some future event such as marriage or birth. If the next taker of an interest was unascertained at the time of the creation of the interest, strict common law rules required ascertainment prior to termination of a prior estate *(see* ESTATES, ADMINISTRATION OF); otherwise the title or seisin was in abeyance and the conveyance void *(see* REAL PRQPERTY AND CONVEYAKCING, LAWS OF). The term was also used in connection with offices and titles *(see* PEERAGE). (A. DM.)

ABGAR, the name of several kings of a dynasty that reigned in Osroene (*q.v.*) in Mesopotamia, with their capital at Edessa. According to legend, Abgar V. Ukkama ("the Black"), (4 B.C.–A.D. 50), afflicted'with leprosy, had heard of Jesus' miracles, and wrote to Jesus acknowledging his divine mission, asking to be cured and inviting him to Edessa. Jesus wrote to him in reply that after the completion of his earthly mission he mould send one of his disciples to heal the king. In its oldest form this legend emerges in Eusebius *(Ecclesiastical History,* i, 13), who claims that it had come into his possession from the archives of Edessa. A developed form of it exists in the *Doctrine of Addai,* a Syriac document that seems to contain some reflections of the primitive Christianity in Edessa. Jesus' reply to Abgar has long been used in the Syrian and Egyptian orient as a magic amulet.

It has been thought that the legend is an echo of the beginnings of Edessene Christianity, under Abgar IX (179–214). The view, however, that Abgar IX received the Christian faith. though popular. is doubtful. *The Book of the Laws of the Nations,* the earliest monument of Syriac literature, emanating from the traditions of Bardesanes (*q.v.*), says that when this Abgar became a believer he forbade castration. However, the words "became a believer" appear to be an interpolation caused by the Abgar legend. Eusebius quotes the same source *in extenso,* but these words do not appear in the text he used. *See* also EDESSA: *Edessene Christianity.*

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ABHDISHO BAR BERIKHA (EBEDJESUS; OF NISIBIS: d. 1318), was the last important writer among the Nestorians (*q.v.*). Abhdisho ("servant of Jesus") became bishop of Shiggar and Beth-Arbaye about 1285, and by 1291 mas metropolitan of Nisibis and Armenia. Though few details of his life are known, a complete list of his writings prepared by Abhdisho himself is preserved. This includes some works no longer extant, such as his biblical commentary; 12 treatises on science, ecclesiastical decisions and canons. and another against heresies; and a commentary on a letter dealing with alchemy addressed to Alexander the Great allegedly from Aristotle. Among those extant are his *Marganitha* ("Pearl"), a theological treatise written in 1298 in five sections on God, the creation, the Christian life, the sacraments and the signs of the world to come, a work which may be regarded as a statement of Nestorian doctrine toward the end of its development. Parts of an Arabic translation of it made by Abhdisho in 1312 are cited by the historian 'Amr ibn Matta. The *Collection of Synodical Canons* or *Nomocanon* dealing with civil and ecclesiastical law depicts the organization of the Nestorian church in his day. His *Paradise of Eden,* 50 homilies published in 1291. is a metrical tour de force. The most cited of his works is his *Catalogue,* written in 1316. a list of titles covering the books of the Bible, Syriac translations of Greek fathers and works of Syrian fathers, chiefly Nestorian. It gives no information about dates or contents, but it does mention works otherwise unknown.

See A. Baumstark, *Geschichte der Syrischen Literatur,* pp. 323–325 (1922); J. B. Chabot, *Littérature syriaque,* pp. 139–141 (1934). (W. D. MCH.)

ABHINAVAGUPTA (fl. A.D. 1014). an outstanding Indian philosopher, ascetic and writer on aesthetic theory, was a Rashmiri Brahman and a spiritual descendant of the 9th-century Kashmiri Somananda, founder of the "recognition" (pratyabhijna) school of Kashmiri Sivaist monism. Together with Somananda's disciple, Utpaladeva, he is the most important representative of this school. He conceived Siva, the I or consciousness, and the All as synonymous; and multiplicity or objectivity as an expression of the freedom and strength of the I which through it affirms and realizes itself precisely as I, consciousness or freedom. This concept of freedom *(svatantrya)* is one of the principal achievements of Kashmiri Sivaist thought. Abhinavagupta's chief philosophical works are the *Isvara-pratyabhijna-vimarsini* and the fuller *Isvara-pratyabhijna-vivriti-vimarsini.* The extensive *Tantra-aloka,* summarized by him in the *Tantra-sara,* is one of the most important works on Tantrism. A most beautiful and profound philosophico-religious work is his commentary on *Para-trimsika.* His most notable works upon aesthetics are his commentaries on the *Natya-sastra* of Bharata, and on the *Dhvani-aloka* of Anandavardhana.

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ABIATHAR, in the Old Testament, son of Ahimelech, priest of Nob. He alone escaped from the massacre carried out by Doeg. Fleeing to David, he remained with him throughout his wanderings and his reign. He was loyal through the rebellion of Absalom, but supported Adonijah against Solomon and was banished to Anathoth. He probably represents an early rival house to that of Zadok, the official priestly family of Jerusalem down to the exile. *(See* especially I Sam. xxii *et seq.;* II Sam. xv, xx; I Kings i, ii. iv.) *See* also SOLOMON.

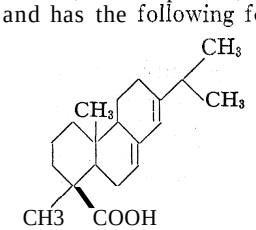
ABIDJAN, capital of the Ivory Coast. west Africa, stands on a promontory of the mainland shore, overlooking Ebrié lagoon and linked by bridge to its southern quarter on the island of Little Bassam. Pop. (1955) 127,585. A village in 1898, the town became capital of the colony in 1933. Its wide, shady avenues and gardened squares are flanked by modern buildings for the town

hall, government offices, law courts, consulates and other public and private purposes. There are a *lycée,* a technical college, a theatre, and also a library and museum of ancient art under the direction of the Institut Français d'Afrique Noire. The town has an average temperature of 79.7" F. The beach, the forest of Banco, and the botanical gardens at the old capital of Bingerville to the east are popular resorts; there are three stadiums and two swimming pools.

Abidjan has been a rail terminus since 1904 but lacked port facilities, depending on the inadequate Port Bouet on the ocean shore of the sand bar south of the lagoon. But a long-cherished project of cutting the sand bar and linking the capital itself to the sea was consummated when the seaport of Abidjan was opened in 1951. The Houphouet-Boigny road-rail bridge, joining the mainland to Little Bassam, was opened to traffic in May 1958 and is a notable engineering achievement. The airport near Port Bouet, 10½ mi. from the capital. is served by French and other airlines. Motorable roads run to Upper Volta, Guinea and Ghana.

Abidjan is a trading and commercial centre; its local industries include soap manufacture, canning. sawmills and breweries. Exports are coffee, cocoa, timber and bananas; imports include textiles, machinery. petroleum and food products. (P. DU P.)

ABIETIC ACID is a constituent of the exudate (oleoresin) flowing from the incised trunks of conifers. Various species of pine may serve as a source, among them *Pinus* abies and *Pinus palustris.* Distillation of the exudate gives the volatile oil of turpentine, consisting largely of the monoterpenoid α-pinene and a residual resin known as rosin or colophony. This is rich in abietic acid. partly because of the oleoresin's original content and partly because other resin acids change to abietic acid during heat treatment. Abietic acid, a diterpenoid, is purified through the diamylamine salt and has the following formula:



If fresh oleoresin is allowed to stand at low temperatures, a crystalline mass of mixed acids known as galipot is formed. From this mixture some of the less stable resin acids can be obtained. Rosin is one of the cheapest large sources of organic acids. The sodium salt, a low-grade soap, is used as an emulsifying agent and as a size in paper-making. Since the rosin acids are highly susceptible to air oxidation, some of their heavy metal salts are used as driers for paints and varnishes. Rosin esters also are used in the paint industry. See also RESINS: Oil-Soluble *Resins;* ROSIN. (P. DE M.)

ABIGAIL (ABIGAL), in the Old Testament, the wife of Nabal the Carmelite of southern Judah, on whose death she became one of the earlier wives of David (I Sam. xxv). By her David had a son, whose name appears in the Hebrew of II Sam. iii, 3 as Chileab, in the Septuagint as Daluyah and in I Chron. iii, 1 as Daniel. The name Abigail also was borne by a sister of David's (I Chron. ii, 16 ff.). From the former (self-styled "handmaid"; I Sam. xxv, 25 ff.) is derived the 16th- and 17th-century colloquial use of the term for a waiting woman.

ABIJAN (Heb. ABIYYAH and ABIYYAHU, "Yah is father"), a name borne by nine different persons mentioned in the Old Testament, of whom the most noteworthy are the following. (1) The son and successor of Rehoboam, king of Judah (II Chron. xii, 16; xiii), reigned about two years (918–915 B.C.). The accounts of him in the books of Kings and Chronicles are very conflicting. The Chronicler says that he has drawn his facts from the Midrash (commentary) of the prophet Iddo. This is perhaps sufficient to explain the character of the narrative. (2) The second son of Samuel (I Sam. viii, 2; I Chron. vi, 28). He and his brother Joel judged at Beersheba. Their misconduct was made by the elders of Israel a pretext for demanding a king (I Sam. viii. 4). (3j A son of Jeroboam I, king of Israel; he died young (I Kings xiv, 1 ff., 17). (4) Head of the eighth order of priests (I Chron. xxiv, 10), the order to which Zacharias, the father of John the Baptist. belonged (Luke i, 5).

ABILDGAARD, NIKOLAJ ABRAHAM (1743–1809), Danish painter, was born in Copenhagen. Sept. 11, 1743. and studied in Rome during 1772–77. His style was classical, though with a romantic trend, and he had a remarkable sense of colour. He enjoyed great fame in his lifetime and taught at the Danish Royal Academy of Fine Arts, of which he became director in 1789. He died at Frederiksdal, Den., on June 4, 1809. Bertel Thorvaldsen was his pupil. (S. Sz.)

ABILENE, a city of Kansas, U.S., located about 95 mi. W. of Topeka, mas settled on the Smoky Hill river in 1858, and became the seat of Dickinson county in 1861.

In 1939 Abilene adopted a commission-manager form of city government. (For comparative population figures see table in KANSAS: *Population.*) Joseph McCoy (1837–1915), a cattle entrepreneur and later mayor of Abilene, selected Abilene for the northern terminus of the Texas cattle drives in 1867, the year the Kansas-Pacific railroad reached this point. The biggest year of cattle drives to Abilene over the Chisholm trail was 1870 when more than 5,000 cowboys driving 700,000 cows arrived at the yards. The appearance of homesteaders and fenced ranges discouraged the Texas cattle trade, much of which was diverted to Wichita. There is still a considerable trade in cattle, however, and grain and poultry markets are centred in the city. Flour and milk products are also important to the city's economy. The Eisenhower museum was opened in 1954 in Abilene, the boyhood home of the 34th president of the United States. (D. P. G.)

ABILENE, a city of Texas, U.S., about 150 mi. W. of Fort Worth almost at the geographical centre of the state, is the seat of Taylor county. Named after Abilene, Kan., its site was determined by the route of the Texas and Pacific railway. On March 16, 1881, the first sale of building lots was held for the city of Abilene. The city adopted a council-manager form of government in 1947. The population in 1960 was 90,368. (For comparative population figures see table in TEXAS: Population.)

Abilene is the distributing centre for a farming and stock-raising region. Outside the city are many producing petroleum pools; natural gas is abundant. Abilene has more than 100 wholesale concerns and is headquarters for many oil companies and oil-well supply firms. Cottonseed and peanut products, feeds, pressed brick, dairy products, clothing, oil-field equipment, soap and watches are manufactured. The West Texas fair is held there. There are three denominational institutions of higher learning: Hardin-Simmons university (Baptist) founded in 1891, Abilene Christian college (Church of Christ) founded in 1906 and McMurry college (Methodist) founded in 1922. The Abilene state school cares for and trains pupils of retarded mental development. Dpess air force base is located there. (R. N. R.)

ABIMELECH (Hebrew for "the [divine] Father is Icing"), the name of two well-known Old Testament personalities, and a common west Semitic name known in various forms from extra-biblical documents.

1. ABIMELECH was a king of Gerar in south Palestine with whom Isaac had relations (Gen. xxvi). Isaac's dealings with Abimelech were a part of the common struggle over grazing and water rights during the period. The story of Isaac's representing his wife Rebekah to be his sister in order to facilitate his relations with Abimelech has its parallel in the story of Abraham's having declared Sarah to be his sister (Gen. xx); another close parallel appears in Gen. xii, telling of the pharaoh's having taken Sarah as his wife, believing her to be Abraham's sister. These stories are chiefly designed to show how God protected the people of the promise even when they lacked courage and faith. In the first two of these accounts, the foreigner Abimelech is represented to be more upright and ethically sensitive than are Isaac and Abraham.

2. ABIMELECH, a son of Jerubbaal or Gideon (*q.v.*) by his Shechemite concubine (Judg. viii, 31; ix). On the death of Gideon, Abimelech set himself to assert the authority which his father had earned, and through the influence of his mother's family won over the citizens of Shechem. Furnished with money from the treasury

of the temple of Baal-berith, he hired a band of followers and slew 70 (*cf.* II Kings x, 7) of his brethren at Ophrah, his father's home. Abimelech thus became king, and extended his authority over central Palestine. But his success was short-lived. and the subsequent discord between Abimelech and the Shechemites was regarded as a just reward for his atrocious massacre. Jotham, the only surviving son of Gideon, is reported to have denounced Abimelech to the Shechemites in a fable of the trees who desired a king to rule over them. Not one of the trees was willing to rule. but the bramble gladly accepted.

It has been supposed that this sharply negative attitude toward kingship belongs to a later period of Israelite life. after the prophetic denunciations of the kings of Israel and Judah. More probably, it represents a basic distrust of kingship characteristic of the 12-tribe system of Israel which, for a time, had its centre at or near the old Canaanite city of Shechem. The story of Abimelech's disastrous attempt to establish a kingship over Israel, culminating in his death at Thebez, reveals the importance of Shechem for the life of early Israel; it also indicates that the tribal confederation, despite its political weaknesses and disadvantages, would not yield easily to the monarchical system characteristic of Israel's neighbours. (W. HA.)

ABINGDON, a municipal borough of Berkshire, Eng., lies 7 mi. S. of Oxford and 20 mi. N. of Newbury, in the flat Thames valley where the small river Ock. draining the Vale of the White Horse. joins the Thames. Pop. (1961) 14,283. Area 2.7 sq.mi. The town grew up round a Benedictine abbey founded in 675 which, after being twice destroyed by the Danes, acquired great wealth and importance. The abbot controlled the town and despite serious riots in 1327 the townspeople did not gain local government until 1556 when, the abbey having been dissolved by Henry VIII, Mary I granted Abingdon its first charter, establishing it as a free borough corporate. Holders of the office of high steward have included Queen Elizabeth I's favourite, the earl of Leicester, and Edward Hyde, 1st earl of Clarendon, but after 1709 it became customary to appoint the successive earls of Lindsey and Abingdon. Abingdon was the county town from Tudor times until 1870.

Remains of the abbey comprise a beautiful Perpendicular gateway (the gatehouse now forms part of the guildhall); the Checker (*i.e.*, exchequer) with a vaulted undercroft and a rare chimney; the Long gallery, believed to have been a guesthouse; and the restored Checker hall, now used as an Elizabethan-style theatre. The arched bridge over the Thames (1416, widened 1929) gives fine views toward the old part of the town and the Early English tower and Perpendicular spire of St. Helen's church. This, having five aisles, is wider than it is long. In the churchyard are three sets of almshouses, the oldest erected in 1446. The guildhall (1440, with later additions), which has some fine portraits and plate, includes the Roysse schoolroom built in 1563. The county hall (1677) was for 200 years the assize hall of Berkshire and now houses a museum collection. Opposite is St. Nicholas' church, whose west front was built in 1180. Schools include Abingdon (Roysse's) school, which is one of the oldest public schools (*q.v.*) in England. Radley college (1847), two girls' boarding schools and a technical high school.

A Thames-side resort, with parks and other amenities, Abingdon is also a residential area for nearby establishments for research into atomic energy (Harwell) and petroleum. Its manufactures include automobiles, prestressed concrete, scientific instruments and leather products. There are also a large brewery and a substantial agricultural trade, a cattle market being held every Monday. The corporation owns, uniquely, fisheries in the Thames. Ancient customs still maintained are the great Michaelmas fair in the main streets (on the Monday and Tuesday before Oct. 11), the Morris-dance (*q.v.*) along Ock street (on the Saturday nearest June 19) and, on royal occasions, the throwing of 2,500 buns into the market place by the mayor and council from the roof of the county hall. (E. W. J. N.)

ABINGTON, FRANCES (FANNY) (née BARTON) (1737–1815), English actress. daughter of a private soldier named Barton, was first a flower girl (hence her later nickname, Nosegay Fan) and street singer. Employment by a French milliner gave her taste in dress and a knowledge of French that later stood her in good stead. She first appeared on the stage at the Haymarket in 1755 as Miranda in *The Busybody*. In 1756 she joined the Drury Lane company but was overshadowed by Hannah Pritchard and Kitty Clive. After an unlucky marriage with her music master in 1759, she was known as Mrs. Abington. She spent five successful years in Ireland and was then invited by David Garrick to rejoin Drury Lane. There she remained for 18 years, creating many important roles, among which was Lady Teazle in the *School for Scandal* (17 7 She was equally successful in drama, tragedy and comedy. In 1782 Mrs. Abington left Drury Lane and went to Covent Garden. She left the stage in 1790, returning for two years in 1797. Despite her humble origin, her wit, cleverness and ambition won her a place in society. She was a leader of fashion. and a headdress of hers called the "Abington cap" was very widely worn. She died on March 4, 1815. (W. J. M.-P.)

ABIOGENESIS: *see* BIOLOGY: *History: Biogenesis Versus Abiogenesis.*

ABIPON, a South American tribe of the Guaycuruan (*q.v.*) language family, which lived on the lower Bermejo river, in the Argentine Chaco The Abipones acquired fame in anthropological literature because of the much-quoted description of their culture by a Jesuit missionary, Father Martin Dobrizhoffer (pub. in 1784; Eng. trans, *An Account of the Abipones, an Equestrian People of Paraguay,* 1822). These Indians — whose seminomadic bands lived on hunting, fishing, food-gathering and limited agriculture obtained the horse in the 17th century and became the scourge of the Spanish settlements that they raided from the foothills of the Andes to the Paraná river. Their social structure combined the democratic features of primitive bands with incipient forms of a military aristocracy. Conjuration of spirits and spectacular recapture of lost souls by influential medicine men were the salient features of their simple ritualism. The Abipones were settled on various missions by the Jesuits in 1748 (the modern cities of Reconquista and Resistencia in the Argentine were former Abipón missions). Originally perhaps 5,000 strong, they vanished altogether as distinct people in the 19th century. (A. MX.)

ABISHAG, in the Old Testament, the Shunammite nurse of David (*q.v.*) and last addition to David's harem. References to her occur in narratives relative to the close of David's reign, the coronation of Solomon and Solomon's establishment of his position as king (I Kings i, 3. 15–31; ii, 17, 21–22). Found as the result of a search for a beautiful young virgin, Abishag was brought to David's court to serve as nurse and bed mate for the aged king. In the latter role her function was to impart heat to the king's body and to restore his sexual potency. In the counterplot to have Solomon displace Adonijah, Abishag witnessed David's promise to Bathsheba that Solomon would succeed him. Abishag appears lastly as the favourite member of the harem that Solomon inherited from David. Abishag was requested as wife by Adonijah, who engaged Bathsheba to present his request to Solomon, whereupon Solomon had Adonijah murdered.

See Edith Deen, *All of the Women of the Bible* (1955). (C. B. Co.)

ABITIBI, a lake and river in Ontario, Canada. The name is an Xlgonkian Indian word descriptive of the lake's central location on an old canoe route halfway between Ottawa valley and Hudson bay. The lake, on the Ontario-Quebec boundary, is 55 mi. long and has an area of 350 sq.mi. It is shallow, island studded and a popular tourist area.

The river, which flows northward 200 mi. to Moose river, is roughly paralleled by the Ontario Northland railway (Canadian National railways). It has a total length of 340 mi. The forested Abitibi valley is the location of an important pulp and paper industry. Pomer plants at Abitibi canyon, Island falls, Iroquois falls and Twin falls provide 376,000 h.p. for northern mining developments. (F. A. CK.)

ABKHAZ AUTONOMOUS SOVIET SOCIALIST REPUBLIC (ABKHAZIA) occupies the northwestern corner of the Georgian S.S R., U.S.S.R., between the Black sea and the crest of the greater Caucasus range (Bolshoi Kavkaz). Along the coast is a narrow lowland, broken by mountain spurs reaching almost to

the sea, and widening to the southeast. Behind this lowland is a hilly foreland zone of eroded sea and river terraces. backed in turn by the steep slopes of the Caucasus, which rise to 13,254 ft. in Mt. Dombai-Ulgen The sharp relief in close proximity to the sea gives Abkhazia a distinctive climate, the wettest in the U.S.S.R., with annual rainfalls of from 48 to 55 in. on the lowland to 80 in. on the slopes. where up to 120 in. have been recorded. Conditions on the lowland are subtropical and this is one of the few areas of the U.S.S.R. where January average temperatures remain above freezing point. The heavy rainfall gives rise to a large number of rivers, flowing usually in a southwesterly direction and subject to frequent floods during thawing and heavy downpours, while the subtropical climate leads to the formation of subtropical soils, yellow earths and terra rossa, bearing a luxuriant vegetation of more than 1,500 species. The forests of oak, beech and hornbeam which once covered all Abkhazia have been cleared from wide areas of the lowland and foreland zones. Higher up, the trees are mainly coniferous, giving way to meadow. At about 9,000 ft. the snow line occurs. Abkhazia, once the home of the Abkhaz tribe (in Abkhaz Apsua; in Greek Abasgoi) and part of the Roman empire, became Christian under Justinian (c. 550). In the 8th century, Leo. duke of the Abasgoi, formed the kingdom of Abasgia, independent of Byzantium and later part of Georgia. In 1463 the duchy became independent of Georgia only to come under the Ottoman empire in the 16th century when Islam replaced Christianity. In 1810 George I Sharvashidze. prince of Abkhazia, signed a treaty with Russia acknowledging a protectorate and in 1864 Abkhazia was annexed by Russia. The country proclaimed its autonomy in 1919 and was formed into an A.S.S.R. in 1921. The population of Abkhazia in 1959 was 400,000, of which approximately 37% (or 147.000) were urban dwellers. Most of the people are concentrated in the coastal lowland where the larger settlements are located — Sukhumi (*q.v.*), the capital, Ochamchire and a chain of resorts such as Gagra and Novy Afon (New Athos). The one large exception to a coastal location is the coal-mining town of Tkvarcheli in the Galidzga valley, which in 30 years has grown from a village of about 500 to a town of more than 28.000 inhabitants.

The agricultural economy of the country, thanks to the subtropical conditions. has an importance in the U.S.S.R. out of all proportion to its area There is grown the best tobacco of the Soviet Union, particularly in the foreland zone, while the coastal zone is a major tea-producing region. There are 11 tea-processing plants. Other crops of importance are citrus fruits, although, since these have suffered greatly from the abnormal frosts of 1950 and the following years, special precautions are now taken, such as the use of gauze covers in winter. The tung tree, the nut of which is used for oil. is widely grown, while plantations of eucalyptus and bamboo add a characteristic element to the Abkhazian landscape Orchards are numerous, not only of apples, pears, plums and cherries, but also of figs, medlars, quince and olives. The vine has been cultivated since ancient times, although the quality of the wine is not high. Silk is obtained in the lowland. Inland, on the higher areas, timber production is the major occupation, especially in the Bzyb and Kodori valleys. Beech and pine are the most common timbers. Coal was discovered at the end of the 19th century, but only since 1935 has it been mined, centred on Tkvarcheli. In the late 1950s nearly 1,500,000 tons were being produced annually, partly by the opencast process. The rivers are well suited to the production of hydroelectric power and several plants were built. the largest being at Sukhumi. The coastal resorts and the lovely Lake Ritsa are popular holiday and convalescent centres for people from all over the Soviet Union. The main line of communication is the railway along the coast, linking the major towns, with an electrified branch line to Tkvarcheli. Roads lead inland to Lake Ritsa and along the Kodori valley.

(R. A. F.)

ABLUTION, *a religiously prescribed washing of part or all of the human body. or of possessions such as clothing or ceremonial objects. with the intent of purification or dedication (Lat. ablutio, from abluere, "to wash off").* Water, *or water with salt or some other traditional ingredient, is most commonly used, but washing with blood is not uncommon in the history of religions, and urine of the sacred cow has been used in India. The devout Shintoist rinses his hands and mouth with water before he approaches a shrine (haiden) and prepares to clap his hands to draw the attention of the divine (kami) to his devotions. The monk of the southern Buddhist (Theravada) tradition washes himself in the monastery pool as he prepares to honour in his meditations an enshrined relic or image of the Buddha. The upper-caste Hindu bathes ceremonially in water before performing his daily morning* worship (*puja*) *in his home. The Jewish family that does not have a separate set of ritual dishes and glassware for the Passover meal (Seder) may take the traditional course of preparing such dishes by dipping in boiling water; at the same meal the family uses pitcher and* towel *for hand ablutions. The Roman Catholic priest (and priests of some Orthodox churches) celebrating the Mass prepares himself by ritual washing of his hands in the lavabo (a ceremonial basin); after the offertory of the sacred elements there is a ritual washing of the fingers. Seven days after baptism those newly baptized in Eastern Orthodox churches often go through a ceremony in which holy oil is washed from the forehead In some of the Brethren sects in rural United States ceremonial foot washing is performed on stated occasions, continuing in Protestant life what was centuries ago common in Christian piety as a response to the gospel story of Jesus' washing his disciples' feet (John* xiii, *1–15) and to the Pastoral epistle's description of upright widows as having "washed the feet of the saints" (I Tim. v, 10). In Muslim piety it is required that the devout wash their hands, feet and face before each of the five daily prayers; however, in keeping with the koranic claim that God does not desire needless suffering for believers, the use of sand is permitted in place of water where desert conditions make water difficult or impossible of access.*

The Jewish Torah (Mosaic law, embodied in the Pentateuch) contains numerous examples of ablution. At this period of history ablution is only one of many methods for catharsis (see PURIFICATION) *of the dangerous "charge" that was felt by Semitic peoples — as by the Greeks, Romans, Babylonians, Egyptians, Chinese and many primitive peoples — to be associated with death and corpses, women in childbirth, menstruating women, male nocturnal emissions. violent acts and booty of battle, certain diseases, initiation to high office, performance of priestly rites. etc.*

Like most ritual acts, ablution may carry a wide *range of meanings to those who perform it. The stain of ritual uncleanness may be felt to be as real as contamination with unseen germs is for the medically minded, and as productive of suffering and misfortune; or the act of cleansing may be only a gesture, symbolic of desired purity of soul, as Thomas Aquinas thought of ablution in the Mass. Probably both objective and subjective referents are often fused in the act, as C. G. Jung and others have suggested in studies of unconscious elements in religious symbolism. The cleansing often is sought in a perfunctory way. But it may also be sought as a matter of gripping holy (numinous) concern, as* Rudolf Otto *suggested in his analysis of such ritual elements as chants, art and sacrifices. Such concern, compounded of inarticulate awe and adoration, may have no ethical or rational content, as any review of the varieties of ablution will confirm. Yet. as Otto and others have shown, the irrational sense of the holy in such acts as ablution often serves as a vital background upon which worship may develop its profoundest rational and ethical content.*

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(H. H. B.)

ABNAKI (ABENAKI) *designates a confederacy of* Algonkian-*speaking Indian tribes in northeast* North America, which was *organized to furnish resistance and protection against the warring encroachments of members of the Iroquois league of northern* New York *state, especially the Mohawk. In its earliest organization*

it consisted of tribes east and northeast of New York: Maliseet (Malecite) in New Brunswick; Passamaquoddy, a segment from the Maliseet; Penobscot in Maine; and tribes in Vermont and New Hampshire. Later it included some eastern tribes as far south as the Delaware tribe. Some agriculture was practised throughout the coastal region, more intensively from north to south In the northern portion the typical dwelling was the birch-bark covered wigwam. The birch-bark canoe was in general use. Game was taken in snares and traps and by bow and arrow Each tribe consisted of small bands under a head man or chief who had little compulsory authority. There was institutionalized comradeship with mutual responsibility, which united two men for life Belief in a culture hero who will return to help the people in time of great need persists to the present. The *1959* population. including so-called Abenaki groups in Canada, was about *3.300.*

See "Abnaki" in Bureau of American Ethnology, *Handbook of American Indians North of Mexico,* vol. i, pp. 2–6 Bulletin 30 (1907).

(W D. W4)

ABNER, in the Old Testament, Saul's cousin and commander in chief, comes into prominence only after the crushing defeat of Israel at Mt. Gilboa. This battle placed the Philistines in control of the whole of central Palestine, and the weakness of Israel was enhanced by the division into two parties, that of the south. which followed David, and that of Trans-Jordan which remained faithful to Ishbosheth, the son who succeeded Saul. Ishbosheth himself, however, was a weak character, and the whole strength of the party was concentrated in Abner. The struggle between the two parties was continuous, and in the battle of Gibeon Abner killed Asahel, brother of Joab, thus exposing himself to the blood-vengeance of the dead man's whole family. It seems that Abner aspired to become the sole leader of his party and. as a step in the achievement of his aim, married Rizpah. one of the concubines of Saul. For this he was reproved by Ishbosheth and thereupon deserted to the opposite party. An agreement was made between David and Abner. by which David had restored to him Michal, daughter of Saul. thus establishing a claim on Saul's throne, and Abner was received into favour. Joab, however, in obedience to the binding law of blood-revenge, took an opportunity of putting Abner to death, and his disappearance practically brought to an end the resistance of the eastern party. David, of course, was not implicated in Abner's death, and his short dirge over the body, like that over Saul and Jonathan, is an exquisite specimen of the early poetry of Israel. See chiefly II Sam. ii. iii, iv.

ABNEY, SIR WILLIAM DE WIVELESLIE (1843–1920), English chemist, is best known for research on colour measurement and mixture and on photographic processes. He was born in Derby, July *24, 1843.* He was educated at Rossall school and in *1861* obtained a commission in the royal engineers through the Royal Military academy. He was appointed instructor in chemistry and photography at the school of military engineering at Chatham and in *1874* was placed in charge when the department mas made a separate school. In *1877* he entered the science and art department at South Kensington where he was appointed director in *1893.* In *1899* he was made principal assistant secretary to the board of education. After his retirement from this position in *1903,* he served as scientific adviser to the board.

Abney invented gelatino-chloride, or printing-out paper. and discovered the developing power of hydroquinone and the "failure of the reciprocity law." He made the earliest measurements of the relation of the transparency of a photographic image to the exposure and prepared red-sensitive plates, with which he made many observations in the red and infrared regions of the spectrum.

In *1900* he was made knight commander of the Bath. He was elected fellow of the Royal society in *1876.* In *1882* the Royal society awarded him the Rumford medal for his work on spectrum analysis. He was president of the Royal Astronomical society from *1893* to *1895,* of the Physical society from 1895 to *1897,* of the Royal Photographic society from *1892* to *1894.* in *1896,* and for *1903* to *1905.* He received the Royal Photographic society's progress medal in 1878 and *1890.* Abney died in Folkestone, Kent. Dec. 3. *1920.* (C. E. K. M.)

ABO: see TURKU.

ABODE: see DOMICILE AND RESIDENCE.

ABOLITIONIST, an advocate of the abolition of slavery. The term as used in the United States reierred specifically to those persons who, during the years 1830–61, made it their mission to advocate the immediate abolition of Negro slavery. In spite of riots, assaults and persecutions of every kind, they carried on their task by means of the press. tracts, lectures and petitions to congress. Among the outstanding leaders of the abolitionist movement were William Lloyd Garrison, Wendell Phillips, Lucretia Mott and John Brown. *See* SLAVERY.

ABOLITION MOVEMENT, a movement primarily in Britain, the United States and western Europe, between about *1783* and *1888,* to abolish the international slave trade and the institution of chattel slavery.

After Roman slavery was gradually converted into serfdom, slavery was virtually unknown in western Europe until *1442,* when the Portuguese began to bring back Negro slaves from their explorations along the west coast of Africa. Soon after, the need for labour in the colonies of North and South America created an immense market for slaves. Consequently, a vast trade sprang up and flourished for more than three centuries, being dominated in turn by Portugal, Spain, Holland, France and England. Altogether probably more than *15,000.000* slaves were transported. and prior to *1800* far more African slaves than English or European colonists crossed the Atlantic — mostly to the West Indies and South America.

Despite its severity and inhumanity, the slave svstem aroused little protest until the 16th century. Rational thinkers of the Enlightenment then began to criticize it for its violation of the rights of man. and pietistic or evangelical religious groups condemned it for its unchristian and brutal qualities. In Britain and America, the Quakers. who began their criticism in *1671,* were the first significant opponents of slavery, and the dynamics of the antislavery movement were largely religious throuehout. Consequently the leaders were always more concerned with ending the sin of slavery than with finding a constructive social policy for the slaves. In France, where the Société des Amis des Noirs was founded in *1788,* the rational factor was stronger than the evangelical.

By the late 18th century moral disapproval of slavery was widespread and antislavery reformers gained a number of deceptively easy victories. In Britain, Granville Sharp, working almost alone, secured a decision in the Somerset case *(1772)* that West Indian planters could not hold slaves in England, since slavery was contrary to English law. In America leading figures of the revolutionary period, such as Washington, Jefferson and Franklin, condemned slavery unequivocally. Between *1777* and *1801* all of the states north of Maryland abolished it — some by gradual, others by immediate action. Meanwhile, in the south, numerous and vigorous antislavery societies enjoyed considerable success in persuading owners to manumit their slaves voluntarily.

These victories, however, had little effect upon the centres of slavery, the great plantations of the deep south, the West Indies and South America. The antislavery movement, therefore. slowly turned to the problem of slavery in these areas, and as it did so, it passed through three major phases.

The first phase involved British and American efforts to prohibit the importation of African slaves into the British colonies and the United States. English Quakers began actively to campaign for such a prohibition in *1783.* In *1787* the Abolition society, consisting mostly of Quakers, was formed. Under William Wilberforce (*q.v.*), who led the movement in parliament, and Thomas Clarkson (*q.v.*), who devoted many years to the tireless collection of evidence concerning the evils of the trade, the antislavery forces waged an unremitting contest against extremely powerful opposition. After two decades the trade to the British colonies was abolished in *1807.*

Meanwhile in the United States: the Constitutional Convention in *1787* had considered placing in the constitution a prohibition of the trade, but in order to conciliate southern interests which opposed immediate action the convention agreed to a provision that

congress might prohibit the trade after 20 years. Accordingly, in 1807 the United States also prohibited it.

Antislavery men had hoped that when the supply of new slaves was stopped, slavery itself would gradually wither away. But this did not follow, and in its second phase abolitionism concentrated upon the emancipation of populations already in slavery. In Britain antislavery leaders organized the Anti-Slavery society in 1823, made Thomas Fowell Buxton (*q.v.*) their parliamentary leader in place of the aging Wilberforce and, after another prolonged and dramatic contest, finally succeeded in 1833 in passing a law to free all slaves in the British colonies after a six-year period of apprenticeship, with compensation to their owners. In 1838 France also abolished slavery in its West Indian colonies. This was France's second attempt, for the French revolutionists in 1794 had proclaimed emancipation but the internal struggle over this question in Haiti had led to bloody and violent uprisings. During a vain attempt to restore French control of the island, Napoleon re-established slavery (1802), and it continued in other French colonies until 1848.

The British abolition movement had a deep influence in the United States. As the cotton economy developed, slavery gained new vigour and the south began to defend slavery in positive terms. Discouraged by these developments and disappointed by the limited results of their appeals to gradualism and persuasion and their attempts to colonize free Negroes in Liberia, U.S. antislavery men turned, about 1830, to a more militant policy. Denouncing all slaveholders, they demanded immediate abolition by law. In this aggressive program the most conspicuous and most extreme leader was William Lloyd Garrison (*q.v.*), editor of the Liberator (1831) and founder of the American Anti-Slavery society (1833). But Garrison's actual following was small, and it is quite possible that a greater influence was exercised by the burning evangelist Theodore Dwight Weld, who with his "Seventy apostles" carried the gospel of antislavery to pulpits throughout the north. Also, the activity of free Negroes, of whom Frederick Douglass (*q.v.*) was the most important, is not to be underestimated.

U.S. abolitionism laboured under the handicap that it threatened the harmony of north and south in the union, and it ran counter to the constitution, which left the question of slavery to the individual states. Therefore the northern public remained unwilling to adopt abolitionist policy and distrustful of abolitionist extremism, as illustrated by John Brown's raid at Harpers Ferry (1859). Even when convinced of the evil of slavery as they were by Harriet Beecher Stowe's Uncle *Tom's* Cabin (1852), most northerners rejected abolitionism. But they were prepared to resist the spread of slavery into new territories. The election of Abraham Lincoln as president on this issue in 1860 led to the secession of the southern states and to the Civil War (1861–65). The war, in turn, led Lincoln, who had never been an abolitionist, to emancipate the slaves in areas in rebellion (1863), and led further to the freeing of all other slaves by the 13th amendment to the constitution in 1865.

Meanwhile, the third phase of the abolition movement had already begun as Britain took the lead in efforts to break up the remaining slave trade. All leading countries, by this time, had enacted lams against the trade, but smuggling was extensive and open. In fact, the closing of U.S. and British markets had merely deflected the trade to Cuba, Brazil and elsewhere! and as late as 1850 more than 50,000 slaves a year were being transported. A new organization, the British and Foreign Anti-Slavery society, was therefore formed in 1839 under the leadership of Joseph Sturge. While this society kept up a public agitation, the British government sought to obtain international agreements to stop the trade by means of an effective naval patrol, but the profitability of the trade and jealousy of British naval power both stood in the way. In 1862, however, the United States signed a treaty conceding the right of search, which was necessary for effective enforcement. After this treaty, the slave trade was quickly reduced to a trickle. Later, the world-wide reaction against slavery led to abolition in Cuba, between 1880 and 1886, and in Brazil, between 1883 and 1888. Some slavery, of a rather different kind, still prevailed in parts of Africa and Asia and was still the target of reformers' activities. But the system of African slavery as a western phenomenon, after shaping the destiny of three continents and dominating the history of three centuries, had ceased to exist. See also SLAVERY. (D. PR.)

ABOMINABLE SNOWMAN, a mythical monster supposed to inhabit the Himalayas at about the level of the snow line. No one has ever seen an Abominable Snowman, or Yeti, alive or dead. but certain marks found in the snow have been attributed to it. Where these have not been caused by lumps of snow or stones falling from higher regions and bouncing across the lower slopes, they have probably been produced by bears: at certain gaits bears place the hind foot partly over the imprint of the forefoot, thus making a very large imprint that looks deceitfully like an enormous human footprint traveling in the opposite direction. Credulity is strengthened by the legends current among the Sherpa natives of the neighbouring regions about the Yeti, the local bogyman. Specimens of hair alleged to have come from the Abominable Snowman have proved on scientific examination to be hairs of bears, yaks or other well-known animals. One such specimen, a dried scalp, preserved in a monastery of Tibetan lamas, is the skin, molded to shape during drying, from the back of a serow, a goatlike mountain antelope. (L. H. M.)

ABOMINATION, anything regarded with aversion as things contrary to omen (Lat. ab, "from," *omino,* "I forebode") ; in the Old Testament, evil doctrines, impure ceremonial practices and heathen idols. The Hebrew words thoava and *shikkuz* became *bdelygma* in the Septuagint (Greek version of the Bible) and *abominatio* in the Vulgate (Latin version), the latter term passing into modern European languages. The gospel expression translated in the Authorized Version as "abomination of desolation" (Matt xxiv, 15; Mark xiii, 14; "desolating sacrilege" in the Revised Standard Version) derives from Dan. xi, 31 and xii, 11 ("the abomination that makes desolate"), where it refers to a statue of Zeus Hypsistos (Semitic Baal Shamaim, "Lord of Heaven") erected in 167 B.C. by the Seleucid king Antiochus IV Epiphanes in the temple at Jerusalem. (J. T. M.)

ABOR, an Assam tribe inhabiting hills north of the Brahmaputra river in northeastern India, subdivided into Minyong, Galong, Padam and other groups. They fall into patrilineal exogamous septs or clans with traces of dual organization. A cross division exists into Mishing and Mipak — pure and impure, the latter condition being hereditary and contagious as a result of sexual intercourse: though exogamy is not affected by it. The dead are buried; monogamy prevails, but the Galongs practise the levirate (*q.v.*) and polyandry within the family circle; slavery, tattooing and segregation of the unmarried obtain. Public affairs are managed by elders and offenders are fined by the random confiscation of property. Weapons used include long swords, crossbows, bows, poisoned arrows and spears. Men wear bark loincloths with tails, women a string of small circular metal plates.

ABOR HILLS: see SIANG FRONTIER DIVISION.

ABORIGINES, the inhabitants found in a country at its first discovery. The aborigines were a mythical people of central Italy, supposed to have descended from near Reate (an ancient Sabine town) upon Latium, whence they expelled the Siceli and settled down as Latini under a King Latinus. The etymology of the name (ab *origine*) makes them the original inhabitants (Gr. *autochones*) of the country, but is inconsistent with the fact that the oldest authorities (*e.g.*, Cato in his *Origines*) regarded them as Hellenic immigrants, not as a native Italian people. Other explanations suggested are *arborigines,* "tree-born," and aberrigines, "nomads." See RACES OF MANKIND.

ABORTION may be defined as the termination of pregnancy before independent viability of the fetus has been attained. It is one form of human reproductive wastage, the general descriptive term for loss of embryonal and fetal lives in reproduction. Wastage may occur throughout pregnancy, during the birth process and in the first days following delivery. Very few fetuses weighing less than 1.000 g. (2 lb. 3½ oz.) and born earlier than 24 weeks after conception survive, and pregnancies terminated prior to this period are generally considered abortions. Expulsion of a dead fetus later in pregnancy is called stillbirth, and birth of a living infant

before term is called premature birth. Miscarriage is a folk term for spontaneous abortion.

The distinction between abortion and stillbirth is not agreed upon by all persons and all governments, and the World Health organization in 1950 recommended that neither term be used, suggesting instead that when a fetus is born dead it be classified in one of four groups: group I, early fetal death — pregnancy of less than zo weeks; group II, intermediate fetal death — pregnancy from zo to 28 weeks; group III, late fetal death — pregnancy of more than 28 weeks; group IV, fetal death with length of pregnancy unknown.

It has been estimated that 10% to 12% of all pregnancies terminate as abortions. Early abortion may occur before the young pregnancy has obtained a secure attachment to the uterine lining. Many such early abortions are not recognized by the patient or her physician because they induce no recognizable symptoms.

The failure of a baby to survive pregnancy may be the result of a number of factors, among them physical impairment of the mother; a complication of pregnancy; or abnormal condition of the baby or its environment. Abnormalities of the developing embryo and chorionic sac which contains it are the result of intrinsic defects in the germ cells (that is, of defects existing in the egg or sperm before conception took place); uterine lining poorly prepared because of insufficient hormones; or gross alteration of the environment by tumours of the uterus, infections, or congenital or acquired defects. The ovarian hormones estrogens and progesterone are necessary for the establishment and normal progress of early pregnancy, and inadequate secretion of them may result in abortion. Psychogenic factors also are probably responsible in some cases. A mother who has acquired diabetes during childhood or adolescence may experience a fetal death or give birth to an excessively large child who may fail to overcome the results of the abnormal environment provided by its diabetic mother. The mother who has Rh-negative blood married to a husband who is Rh-positive may become immunized in her first or subsequent pregnancies and the baby may develop a serious anemia and succumb in the uterus or (rarely these days) after birth. A mother may have high blood pressure or kidney disease which become aggravated during pregnancy. The inadequate circulation to the uterus under such circumstances may interfere with the development of a normal placenta, or this important structure may undergo early senile changes, so that the baby is deprived of an adequate blood supply and it dies in the uterus or its growth and development are retarded.

A fetal death may result when a baby who moves freely in the uterus becomes entangled in its umbilical cord, cutting off its oxygen supply. The placenta may become partially separated from its uterine attachment, likewise interfering with oxygenation and occasionally initiating early labour. A baby may develop major malformations, resulting in its death during pregnancy or immediately after its birth. Infections of the baby can occur in late pregnancy, particularly if the fetal sac ruptures some time prior to the onset of labour, or in the early days following birth. Some of these infections are due to staphylococcus organisms which may be resistant to antibiotic therapy.

A few women, designated as habitual aborters, have repeated abortions. In these women some recurrent factor or factors predispose to the early termination of pregnancy. Complete and careful diagnostic study and proper therapy will prevent the recurrence of abortion in most of these women.

The course of an abortion varies. The embryo may die and its expulsion from the uterus may be delayed for several weeks or even several months. The abortion process may begin with lower abdominal pains, resembling menstrual cramps, and slight bleeding. At this stage damage to the gestation may be slight, and proper treatment may result in continuation of the pregnancy and a healthy child. In other cases the abortion process starts with profuse bleeding and severe cramps, indicating a rapid separation of the gestational sac from its uterine attachment and its expulsion from the cavity of the uterus. The physician will usually complete such an abortion surgically and make certain that no remnants of the pregnancy remain in the uterus.

In most countries medical ethics and the law permit the deliberate termination of pregnancy (therapeutic abortion) when the mother's health, life or reason are seriously jeopardized by the continuation of the pregnancy and when grossly defective offspring may surely be expected. The frequency of therapeutic terminations of pregnancy is decreasing rapidly with the advances of medical knowledge. In many parts of the world a person who willfully causes an abortion, as well as anyone who contributes to the act in the absence of medical indications, is liable to conviction of crime. The frequency of such criminal abortions is unknown, but they contribute to much invalidism and death. Infection is a common complication and may result in the inability to have children.

See EMBRYOLOGY, HUMAN; FETAL DISORDERS; OBSTETRICS: PLACENTA AND FETAL MEMBRANES, DISEASES OF; PREGNANCY; PREMATURE BIRTH; STILLBIRTH; *see* also Index references under "Abortion" in the Index volume.

See P. H Gebhard *et al., Pregnancy, Birth and Abortion* (1958); C. T. Javert, *Spontaneous and Habitual Abortion (1957).*

(M. E. Ds.)

ABORTION, CONTAGIOUS: *see* BRUCELLOSIS.

ABOUT, EDMOND FRANÇOIS VALENTIN (1828–1885), French novelist and journalist, a vigorous polemist who effectively introduced a mordant humour into the most serious subjects, was born on Feb. 14, 1828, at Dieuze, in Lorraine. After a period at the École Normale he went to Greece with a grant from the French school at Athens. On his return he published *La Grèce contemporaine* (1854), a bitingly satirical and occasionally unfair account of his personal impressions. Turning to novel writing, he published the whimsical *Le Roi des montagnes* (1856), showing an individual humour later echoed by Daudet, and attempted realism in *Tolla* (1855), *Germaine* (1857) and *Madelon* (1863). About resumed his humorous style with *Le Cas* de *Monsieur Guérin, L'Homme à l'oreille cassée* and *Le Nez d'un notaire* (all 1862), his best works.

Under Napoleon III, About proclaimed his liberal views in La *Question romaine* (1861) and *Le Progrbs* (1864). Following the establishment of the Third Republic he founded in 1871 a periodical, the *XIX^e Siècle,* in which he showed himself a brilliant journalist and controversialist, with a formidable wit. A convinced anticlerical, he campaigned for the secularization of French education. Elected to the Académie Française in 1884, About died in Paris on Jan. 16, 1885.

See M. Thiébaut, *Edmond About* (1936). (R. DL.)

ABOYNE, a village of Aberdeenshire, Scot., lies on the river Dee. 31 mi. W. of Aberdeen by road. Pop. (1961) 1,544. It is a picturesque village with a large green where the Aboyne Highland games are held every September. To the north is Aboyne castle, for centuries the seat of the marquises of Huntly. At Aboyne the Dee is crossed by a fine bridge (leading to Glen Tanar), and nearby is the Queen's loch. Local industries are farming and sawmilling, and there is a fortnightly market for cattle and sheep. Michael fair is a well-known sheep sale held every autumn.

(Jo. F.)

ABRA, interior province in northwestern Luzon, Republic of the Philippines. Area 1,471 sq.mi. Pop. (1960) 116,700. Hilly and mountainous, it is drained by the Abra river, whose flood plain is the principal level terrain. The main crop is rice, with tobacco and corn of secondary and lumbering of minor importance. Bangued, the capital, is the chief settlement and commercial centre. The inhabitants are principally Ilocanos, and secondly Igorots (mountain people). (AN. C.)

ABRABANEL (ABRAVANEL or ABARBANEL), **ISAAC** (1437–1508), Jewish statesman, philosopher, theologian and commentator, was born at Lisbon, Port., of an ancient family which claimed descent from the royal house of David. Like many of the Spanish Jews he united scholarly tastes with political ability. He was a favourite of King Alfonso V, who entrusted him with important state business, but after the king's death in 1481 Abrabanel was compelled to flee to Spain, where for eight years (1484–92) he held the post of a minister of state under Ferdinand and Isabella. After the expulsion of the Jews from Spain in 1492 Abrabanel resided at Naples, Corfu and Monopoli, and in 1503 moved to

Venice, where he was a minister of state until his death in 1508.

Abrabanel was one of the first to see that for biblical exegesis it was necessary to reconstruct the social environment of olden times, and he applied his practical knowledge of statecraft to the elucidation of the books of Samuel and Kings.

Bibliography. — J. S. Minkin, *Abarbanel, and the Expulsion of the Jews From Spain* (1938); J. Sarachek, *Don Isaac Abravanel* (1938); B. Netanyahu, *Don Isaac Abrabanel, Statesnzan and Philosopher* (1953).

ABRACADABRA, a word analogous to abraxas (*q.v.*), used as a magical formula by the Gnostics of the sect of Basilides (*q.v.*) in invoking the aid of beneficent spirits against disease and misfortune. It is found on abraxas stones, which were worn as amulets. The Gnostic physician Serenus Sammonicus gave precise instructions as to its mystical use in averting or curing agues and fevers generally. Subsequently its use spread beyond the Gnostics, and in modern times it is applied contemptuously to complicated. unscientific hypotheses.

ABRAHAM, the first of the Hebrew patriarchs, stands at the fountainhead of the history of redemption in the Bible.

Traditions About Abraham in Genesis. — In the prologue to the tradition about Abraham in Gen xi the origin of Abraham, at first called Abram, is traced to Harran in northern Syria and to Ur of the Chaldees in the lower Mesopotamia valley. The prologue connects the history of Abraham (Gen. xi, 26–xxv. 10) with the primeval history of Gen. i, 1–xi, 9. Therein Abraham is a symbol of God's plan of redemption for the world.

In Gen. xii Abraham's story proper begins. His call is described briefly (xii, 1 ff., part of the "J" tradition; see PENTATEUCH). God commands him to break away from his environment and to go out to a new land. The promise of progeny and of material felicity is given to him. Furthermore, he is to act as intermediary for this blessing to "all the families of the earth" (xii. 3).

The theological importance of these opening verses cannot be overemphasized. Abraham is from now on to live on God's word (God's providence) alone, but in a hostile world (xii, 6). Abraham's unhesitating acceptance of his call is described in a single word in the Hebrew ("so [he] went"; xii, 4). The meaning of the story lies in Abraham's obedience to God. his severing of his ties with his former life and his achieving of a new existence based on one single thing: God's promise.

The journeyings of Abraham are related in the subsequent material. He comes to Shechem, builds an altar there and receives the divine promise that his descendants will inherit the land (xii. 7). On his way south through the central mountain ridge of Canaan, he pauses at Bethel, where he builds another altar and worships, and then comes to the Negev, where he settles close to Hebron (xii. 9; xiii. 18). It is in this southern area that the traditions about Abraham most probably belong, and the body of the tradition actually begins to develop at this point (xii, 10). When Abraham journeys from Hebron down to Egypt for better grazing grounds, which is normal nomadic practice, the story for the first time takes on flesh and colour, reporting incidents and describing people. Because of the beauty of his wife Sarah, he meets trouble in the land of Egypt, but he is saved by his presence of mind and the power of Yahweh (xii, 11 ff.; cf. xx, 12, where Sarah is reported to be Abraham's half sister).

The narrative moves from the story of Lot in ch. xiii (continued in ch. xix) and the puzzling ch. xiv on toward the important event of God's covenant with Abraham in ch. xv. Ch. xiv is somehow intrusive in the story, and it is strangely foreign to the traditions about Abraham. In it Abraham appears as a warrior who, in order to help Lot, his captured kinsman, campaigns against four foreign kings who had made war on Bera, king of Sodom, and his four allies. (The names of these Canaanite allies do not occur in other sources, and scholars have not identified any of them with certainty.)

The campaign incident in ch. xiv connects Melchizedek, king of Salem (Jerusalem), with Abraham. He blesses Abraham who, in his turn, swears to Melchizedek's God, El Elyon ("God most high"). Here, then, the continuity between Abraham's God and native Canaanite worship is expressed. Thus too, Abraham is linked with Jersualem, the later throne of David, and Melchizedek becomes a symbol of the promises to David (Ps. cx, 4).

Ch. xv contains the account of God's covenant with Abraham—material of unmistakable historical value for the understanding of Abraham and his religion. In several ways the chapter is comparable with the narrative of his call in ch. xii, and it has been suggested that in the oral stage of the tradition this account stood originally at the beginning of the story of Abraham in Canaan.

The chapter falls into two sections, xv, 1–6 and xv, 7–21, relating first the promise to Abraham and second the covenant with him. These two are inseparable and belong almost entirely to "J," the oldest literary tradition of the Pentateuch. In the first section Abraham receives God's promise of progeny in a vision. He was concerned about his childlessness and the possibility that his slave Eliezer would succeed him. (This point is clarified by comparison with the customary law of the 2nd millennium B.C. regarding adoption, as exemplified in tablets found at Nuzi, southeast of Nineveh. A childless man would adopt a son who would serve him in his old age. Should a son be born to the man, the adopted son's status as an heir would be changed.)

This section is highly theological; it brings together the themes of God's promise and man's doubt (xv, 2–4). The tension between the two is resolved only by Abraham's quiet and submissive acceptance and trust (*i.e.*, his faith), which is the occasion for the famous statement "And he believed the Lord; and he reckoned it to him as righteousness" (xv, 6).

The second section, xv, 7–21, is an account of the covenant (xv, 13–16, 19–21 are a later interpolation). During a sacrificial rite, in a "deep sleep" and in "dread and great darkness," Abraham perceives God as a flaming torch passing between the portions of the offering. Here, a covenant rite is easily recognizable (the "passing between" was a part of the ritual). The psychological mystery is expressed through the "deep sleep" during which Abraham's perceptive powers are heightened. Once more the promise given to Abraham concerns the land which his seed is to inherit (xv, 18). Through this account of the covenant, we are given an authentic glimpse into Abraham's cultic experience of the transcendent God who speaks into a human situation.

Abraham's concubine Hagar and her son Ishmael are introduced in the following chapter. In accordance with a type of marriage contract known from the 2nd millennium, Sarah, being childless, had provided her husband with a concubine, who bore him a son. The story of Hagar is resumed in ch xxii, where Abraham is reluctant to "cast out this slave woman with her son" (xxii, 10 ff.) because of Sarah's jealousy. (Nuzi law forbade the expulsion of the slave wife in such cases.)

A second account. ch. xvii. of the covenant with Abraham (from the so-called Priestly tradition), although differing considerably in detail and in theological concern from its parallel in ch. xv, 7–18, is in essentials the same: God establishes a covenant with Abraham and gives him a promise of land and offspring. God reveals himself here as El Shaddai ("God Almighty"; xvii, 1), another form of revelation for Yahweh, as explained in Ex. vi, 3 (also from the Priestly source, "P"). Here, God announces that Abraham is to change his name from Abram to Abraham, showing that he is to become the father (Heb. ab) of a multitude of nations. This is probably a popular etymology. The name Abraham is a longer form of the shorter Abram with the same meaning: "The father [the deity] is exalted." In xvii. 9–14 the rite of circumcision is introduced as the sign by which Abraham's descendants shall be distinguished.

In the following section, also from "P," Abraham is promised a son (xvii. 15–27). The promise is repeated in xviii, 10 (from "J") when God appears in the form of three men whom Abraham entertains to a meal. Later, "at the appointed time," the child, Isaac, is born (xxi, 2; xviii, 14).

At this point a climax has been reached in the narrative. The promise of descendants has materialized at the birth of Isaac. This climax, however. is soon to be countered by the command to sacrifice the boy in ch. xxii.

In the meantime, other material is brought in before and after the birth of Isaac, some of which had belonged originally to inde-

pendent cycles of traditions, such as the story of Lot's escape from Sodom in xix, continuing xiii, 5–13. Abraham journeys in Gerar (ch. xx), is in danger on account of Sarah (xx, 1 ff., a doublet to xii, 10 ff.), makes a treaty with Abimelech of Gerar (xxi, 22–32) and founds the cult of El Olam in Beersheba (xxi, 33).

The great testing point in Abraham's life is then described (ch. xx). God tests his obedience (it is stated explicitly in xxii. 1) by ordering him to offer up his only son, Isaac, as a burnt offering. Abraham leaves Beersheba in obedience and journeys to the land of Moriah (unknown; traditionally Jerusalem). The great scene, holding all the tension of tragedy. is, in true Hebrew narrative style, painted with few but bold strokes. There had been built up in the preceding chapters (xii; xvi; xviii) a climactic account of God's promises and their fulfillment in the birth of Isaac. All this is now to be nullified at one stroke. "The story tells of something far more terrible than human sacrifice: namely of being forsaken by God" (G. von Rad).

At the last moment, God releases Abraham from the terrible injunction. The story, then, finds its denouement in the redemptive word, the command not to harm the boy (xxii, 12), and the accompanying event, the finding of a ram which Abraham offers up in Isaac's place.

The tradition about Abraham in its present form ends with the death of Sarah and the purchase of the patriarchal burial chamber in Hebron (ch. xxiii), the death of Abraham himself and the burial of them both (xxv, 7–10).

Figure of Abraham Elsewhere in the Old Testament. — There is little doubt that David took up the tradition about Abraham to consolidate the religious authority of Jerusalem (Gen. xiv, 19 ff.; Ps. cx, 4). Abraham is the active symbol of the blessing and the promises of the covenant (Ex. vi, 8; Deut. i, 8; II Kings xiii, 23), and as such he is the symbol of the meaning of the nation's history. In Isa. li, 2 he is called the father of Israel, and in Isa. xli, 8 Israel is called "the offspring of Abraham" and Abraham the friend of God.

Abraham in Judaism and in the New Testament. — In rabbinic tradition Abraham occupies a position of eminence. His faith atones for the sins of Israel, and he was even the rock upon which God built and established the world. In the New Testament, allusions are made to this role of Abraham; *e.g.,* in Matt. viii, 11 and Luke xiii, 28–29, where Abraham is an eschatological figure, represented as the host at the heavenly banquet (cf. Luke xvi, 22). The promises to Abraham are recognized as giving the Jews a special prerogative (Rom. ix. 8; xi, 1 ff.). Yet, being children of Abraham has a spiritual, rather than a national, meaning (Rom. ix, 7 ff.; cf. Gal. iii, 9). The true children of Abraham are "children of the promise" (Rom. ix, 8), and that promise is fulfilled in Christ (Gal. iii, 14). Thus Abraham becomes a precursor of Christ. In Him the promises to Abraham are fulfilled (Gal. iii, 25–29; cf. Heb. vii), and Christians, even the gentile ones, partake in the blessing in Abraham (Gal. iii, 8 ff.; *cf.* Gen. xii. 3). Paul seizes upon Abraham's righteousness by faith (Gen. xv, 6) in order to expound his central thesis that righteousness is granted through faith rather than through works (Rom. iv, 1 ff.; Gal. iii, 6 ff.). In the epistle to the Hebrews, Abraham is an example of the faith that receives God's promise and responds to it in obedience (Heb. xi, 8 ff.).

Abraham as a Historical Figure. — The traditions about Abraham in the Bible are derived from oral traditions in epic form. Successive generations retold the stories and applied them to the needs and concerns of their own particular cultic and social institutions. Some of the narratives were probably told in order to substantiate ancient blood ties between clans. Furthermore, the tradition about Abraham is involved with those of Isaac and Jacob in a simple manner, making of the whole a well-rounded story. Behind this simplicity, there undoubtedly lies a vastly complex picture of Hebrew origins in the pre-Mosaic era.

How much can be stated about Abraham as a historical person? Abraham and the other patriarchs have sometimes been considered to be personifications of clans or even figures of myth. This opinion has been proved erroneous. To be sure, the story of Abraham in the Bible is not a biography in the modern sense of the word. The ancients told stories of persons in order to illuminate the meaning of the clan's or the nation's life. Yet, there can be no doubt that Abraham existed. On the other hand, it is not possible to be specific either about when he lived or about the details of his life.

Excavations at Mari on the Euphrates, at Nuzi and elsewhere have yielded texts which illuminate customs, names and tribal history in the first half of the 2nd millennium B.C.; it has become evident that the narratives about Abraham in the Bible authentically reflect that age (or perhaps the middle of the millennium). Abraham was a seminomad who belonged perhaps to a social stratum called Habiru (cf. the word "Hebrew," possibly from the same root, in Gen. xiv, 13).

The religion of Abraham has now been shown, by Old Assyrian inscriptions from the 20th century B.C. and by material of a later period, to belong to a type of high-god religion, which fits the picture given in Genesis. The "God of the Fathers" was a type of deity intimately connected with the clan, whose "patriarch" consciously chose the God and became the founder of the clan's cult. Abraham was such a cult founder (cf. "the God of Abraham," Gen. xxvi, 24).

The literary history of the traditions about Abraham is uncertain in many points because an extremely complex tradition-history has been compressed into a relatively short cycle. As in other histories of the same type, groups of stories have been connected with a particular locality such as Beersheba and Mamre-Hebron. In some cases, the name of the locality has not been preserved, such as the scene of the covenant in Gen. xv. The stories of Lot in xix and of the courtship on Isaac's behalf in xxiv are but loosely tied to the traditions about Abraham. The stories connected with the terebinth grove in Mamre (xviii, 1 ff.) and the cave of Machpelah (xxiii, 19; xxv, 9) locate Abraham in Hebron, where his home probably was. The chronological framework and the ties between independent cycles come from the "P" tradition (xi, 10–27, 31, 32; xvi, 3, 15. 16; xvii; xxi, 3–5, 23; xxv, 7–10). Some of the material assigned to this source, such as the Machpelah story (xxiii), is among the oldest of the traditions about Abraham.

Abraham's Religious Significance. — The story of Abraham centres in three themes: God's call; Abraham's response. in obedience and faith, to God's call; and God's promise to Abraham and its fulfillment. These themes constitute the significance which Abraham had for religious thought in the Bible. The implications of faith for social responsibility were not spelled out until later, in the covenant theology of Moses and his followers (see COVENANT and MOSES), but Abraham, as a figure in history, furnished the directive principles for the life of God's people: faith in God's promise and obedience to God's call.

See APOCALYPTIC LITERATURE for the Apocalypse of Abraham and the Testament of Abraham.

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ABRAHAM, THE PLAINS OF, a plateau to the southwest of the city of Quebec, the scene of the historic battle between the French under Louis Joseph Montcalm (*q.v.*) and the English under James Wolfe on Sept. 13, 1759.

ABRAHAM ECCHELLENSIS: see ECCHELLENSIS, ABRAHAM.

ABRAHAM IBN DAUD (c. 1110–*c.* 1180), Jewish historiographer and philosopher of Toledo, Spain. His historical work was the Book of Tradition (*Sepher ha-Qabbalah*), a chronicle to the year 1161 (Latin trans. by Gilbert Génébrard in Hebraeorum breve chronicon, 1572). His philosophy was expounded in an Arabic work better known under its Hebrew title *'Emunah Ramah* ("Sublime Faith," Ger. trans. by S. Weil, 1852). Ibn Daud was

one of the first Jewish scholastics to adopt the Aristotelian system. His work was, however, soon eclipsed by that of Maimonides and failed to exercise much influence.

ABRAHAM-MAN, the nickname for a vagrant who wandered in England in Tudor times. The phrase is as old as 1561, and was due to these beggars' pretending that they were patients discharged from the Abraham ward at Bedlam insane asylum in London; on his discharge the genuine Bedlamite, provided he wore a badge, was allowed to roam the country, soliciting alms. This privilege was grossly abused, and thus gave rise to the slang phrase "to sham Abraham" — meaning to feign illness.

ABRAHAMS, ISRAEL (1858–1925), the first native-born Anglo-Jewish Hebraist to enjoy a European reputation, was born on Nov. 26, 1858, into a rabbinical family in London. In 1902, after teaching for several years at Jews' college, London, he was appointed reader in Talmudic at Cambridge, where he remained until his death on Oct. 6, 1925. He was distinguished both for the range of his interests and for the lightness of his touch. His *Jewish Life in the Middle Ages* (1896; rev. ed. by C. Roth, 1932), a highly readable social history, was his first major book. His other works include several monographs on medieval Jewish literature and *Studies in Pharisaism and the Gospels* (1917; 2nd series, 1924). From 1889 to 1908 he was co-editor of the *Jewish Quarterly Review,* and he was a leading member of the Jewish Historical Society of England. Orthodox by upbringing, he was later among the founders of the Liberal Jewish movement in England.

(C. R.)

ABRASIVE, relatively hard material used to grind or polish materials softer than itself. Grinding wheels, oil stones and sandpaper are common examples of abrasives. The high precision and fine surface finish of many modern machine tools are obtainable only with the use of abrasive grinding operations. Most household cleansers use a mild abrasive to help the soap or detergent do its work.

Primitive man used abrasives to help shape his stone tools by rubbing them against harder stones. Drawings in ancient Egyptian tombs show the polishing of jewelry and vases with abrasives. In later historical times, craftsmen used natural abrasive stones shaped into wheels, such as grindstones and mill wheels, and into blocks for use by hand for sharpening scythes, knives, axes and woodworking tools. Powdered abrasives were used for polishing in much the same manner as they were used by the Egyptians.

It was not until late in the 19th century, when it became necessary to work with harder metals and to closer tolerances, that abrasives assumed a major role in the manufacturing industry. Synthetic abrasives were developed with improved and more uniform characteristics, and new machines were designed to use these abrasives to best advantage. Natural abrasives are still widely used in some applications, but in industrial grinding they have been largely replaced by synthetics.

Natural Abrasives. — Diamonds are the hardest of all abrasives. The small and imperfect diamonds are crushed and the abrasive powder obtained is graded and used in many grinding and polishing operations, especially on carbide tools, which are difficult to form by any other method. *(See* DIAMOND.)

Corundum (*q.v.*) is a crystalline form of aluminum oxide (Al_2O_3) mined principally in South Africa. It is quite high in cost but among natural abrasives is second only to diamond in hardness.

Emery (*q.v.*) is a mixture of corundum and magnetite (black iron oxide, $FeO{\cdot}Fe_2O_3$), which has been mined for several centuries on Cape Emeri on the island of Naxos in the Greek archipelago. For many years it was the standard industrial abrasive, being formed into emery wheels and emery stones and used to coat cloth. It has now been largely supplanted by synthetic abrasives such as silicon carbide and synthetic aluminum oxide.

Garnet is a silicate of iron and aluminum mined in the eastern United States and in Spain. It is used for making coated abrasive paper and cloth.

Quartz is among the commonest of all minerals and occurs in many forms. Quartz sand is used for making sandpaper and for sandblasting. Sandstone, of which quartz is the main constituent, is used for making grindstones and for sharpening stones. Some compact forms of quartz, such as Arkansas and Washita stone, make the finest oil stones for sharpening knives and other edge tools.

Pumice is the frothy part of lava. It is a relatively soft abrasive used in cleaning and scouring compounds. Other soft abrasives such as diatomite, tripoli, rouge and crocus are used primarily for buffing and polishing operations.

Synthetic Abrasives. — Carborundum, or silicon carbide (SiC), initially prepared in 1891, was the first important synthetic abrasive. It is made by fusing coke and sand at high temperature in an electric furnace. Silicon carbide is harder and stronger than corundum, but inferior to synthetic diamonds and boron carbide in hardness. It is second only to aluminum oxide in its importance as an industrial abrasive and is used for grinding cast iron, tungsten carbide and other hard materials. *(See* SILICON CARBIDE.) Other important synthetic abrasives, in order of hardness, are discussed in the following paragraphs.

Synthetic diamonds are produced commercially and are competing with the natural product. Their greater uniformity justifies their higher cost in some applications.

Boron carbide (B_4C) is, next to diamond, the hardest of all abrasives. It is used for grinding very hard materials such as tungsten carbide, which is widely used in dies and cutting tools.

Artificial aluminum oxide (Al_2O_3), or artificial corundum, is not so hard as silicon carbide but is stronger and is preferred for grinding the common grades of carbon and alloy steel. *(See* CORUNDUM, ARTIFICIAL.)

Iron and steel are sometimes used as abrasives in the form of shot and grit for air blasting and in the form of steel wool for rubbing and polishing.

Industrial Techniques. — Abrasives for industrial use are crushed into a powder which is graded according to size from the coarsest, #6, to the finest, #600. In some polishing and cutting operations these powders are mixed with a liquid or paste and rubbed against the work. Abrasive grains are also cemented or applied as a paste to soft polishing wheels of cloth, felt or leather which are used for buffing or polishing metal or plastic parts to impart a fine finish or as a preparation for electroplating. Most of this buffing is done by hand; however, some operations, such as the polishing of stainless steel sheets, are done in large automatic machines.

In most applications the abrasive grains are pressed into wheels or blocks, using various binders, or are glued to the surface of paper or cloth to form coated abrasives. The wheels may be used in simple hand grinders or in high precision machines for grinding of flat surfaces, for internal and external cylindrical grinding or for the grinding of screw threads or cutting tools. The abrasive blocks may be used as oil stones for the hand sharpening of knives and other edge tools or in honing machines for imparting a fine finish to such parts as automobile cylinders and crankshafts. Coated abrasives include sheets of sandpaper and emery cloth, which have been used for many years for hand finishing of woodwork and metal parts, and synthetic abrasive belts, which are used in belt grinding machines for finishing many metal surfaces.

In sandblasting, the abrasive grains are blown by air pressure or impelled by centrifugal force against the surface of metal castings or other materials for removing rust or scale or smoothing irregularities, or for imparting a slightly rough or matte finish, such as in ground glass. *(See* BLAST CLEANING AND SHOT PEENING.) Ultrasonic machining uses a liquid abrasive mixture flowing under a shaped tool of brass or soft steel which is caused to vibrate at a high frequency. The tool, working in combination with the abrasive, penetrates rapidly even the hardest materials such as ceramics, glass and carbides, leaving a smooth and accurate hole. *See* HARDNESS TESTING; *see* also Index references under "Abrasive" in the Index volume.

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ABRAUM SALTS (Ger. *Abraum-salze,* "salts to be removed"), a mixed deposit of salts originally regarded as rubble or waste material, including chlorides and sulfates of sodium, potas-

sium and magnesium, found in association with rock salt at Stassfurt, Ger. They are a principal source of potassium (*q.v.*).

ABRAXAS (ABRASAX), a word probably first used by the Basilidians (*see* BASILIDES) and engraved on certain stones, called on that account abraxas stones. The Greek letters *abraxas* make up the number 365, and the Basilidians gave the name to the 365 orders of spirits which emanated in succession from the supreme being. These orders were supposed to occupy 365 heavens, each fashioned like but inferior to that above it, the lowest being the abode of the spirits who formed the earth and its inhabitants, to whom was committed the administration of its affairs. In addition to the word abraxas the stones often have cabalistic figures engraved on them.

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ABRAXAS STONE

ABREU, JOÃO CAPISTRANO DE (1853–1927). Brazilian historian, was born near Maranguape, Ceará. Oct 23. 1853. In Rio de Janeiro after 1875. he was a journalist, teacher and member of the National Library staff. From 1883 to 1899 he was professor of Brazilian history at the Colégio Dom Pedro II. Distinguished as an editor and essayist, he was initially influenced by Auguste Comte (*q.v.*) but soon embraced the German school of historical realism. His critical editing of chronicles and of the historian Francisco Adolfo de Varnhagen assured him of high rank among Brazil's historians but his *Caminhos antigos* e *o'povoamento* (1899; 1924) and *Capítulos* de *Histdria Colonial* (1907) give him first place. The former work, often compared to Frederick Jackson Turner's frontier thesis, stressed the importance of the previously neglected backlands. The *Capítulos* reinterpreted and enlarged the scope of Brazilian historiography and became the guide for subsequent historical research and writing. He died in Rio, Aug. 13. 1927. (G. C. A. B.)

ABRON, a west African people, known also as Brong, numbering about 20,000 who live in the Bondoukou region of the Ivory Coast and north of the Ashanti in Ghana. In 1921 the 416 villages in the Abron kingdom included about 30% Brong and 70% Kulango, Agni, Dyula and other nearby peoples. Political and judicial representation are made through the family head (the eldest male) to the village chief, the chief of the province and the king. Descent is patrilineal but inheritance passes normally to the eldest younger brother, or if there are no brothers, to the eldest sister's eldest son. The son of the deceased inherits only if there are no brothers and no sisters' sons. The Abron practise neither circumcision nor clitoridectomy.

The Abron are sedentary farmers who grow bananas, manioc and taro. They recognize a sky god whom they identify with Allah. an earth god and deities of local rivers: they also sacrifice to their ancestors. (WI. B.)

ABRUZZI, DUKE OF THE (LUIGI AMEDEO) (1873–1933), Italian vice-admiral, mountaineer and explorer, born at Madrid on Jan. 29, 1873 (the son of the duke of Aosta, who was then king of Spain as Amadeo), was the first to ascend Mt. St. Elias in Alaska (1897). In 1899 he organized an arctic expedition part of which reached latitude 86° 34' N., at that time the record of northern exploration. In 1906 he was the first to ascend the Ruwenzori in east Africa, reaching the twin summits which he named Margherita and Alexandra. He also made the first detailed map of the Ruwenzori. In 1909 he ascended K-2 in the Himalayas to an altitude of over 20,000 ft. and on July 17 Bride peak to 24,600 ft. During World War I he commanded the naval forces in the Adriatic. but he resigned in 1917 owing to disagreements with Adm. Thaon di Revel, his chief of staff, and retired from the service. Afterward he undertook a colonization scheme on the lower Webi Shebeli in Italian Somaliland, and explored and mapped the river. He died in Somaliland on March 18, 1933.

English translations of his works are *The Ascent of Mount St. Elias (1900)*; *Ruwenzori (1909)*.

ABRUZZI E MOLISE, a region of south central Italy. comprises the provinces of L'Aquila, Campobasso. Chieti, Pescara and Teramo, with a total area of 5,881 sq.mi. and a population of 1,-684.030 in 1951. Most of the region is mountainous or hilly, except for intermontane basins such as those of L'Aquila, Sulmona and the Fucino. The Apennines cover the greater part of the region, consisting of three chains with a northwest-southeast trend. The easternmost of these is the highest, including such peaks as the Gran Sasso d'Italia (9,560 ft) and the Maiella (9.170 ft.); the central group is lower, with Mt. Velino (8.159 ft.); while the western group, comprising the Sabini and Simbruini mountains, does not exceed 7,000 ft. The Apennines are chiefly of limestone, and karstic phenomena (dolinas, caves, underground drainage) are common. In the east, toward the Adriatic. the hills descend gradually to the sea and are of sand or clay. The southernmost part of the region is the rolling plateau of Molise. The coast lacks good harbours for its entire length and fishing does not play an appreciable part in the economy. The principal rivers draining toward the Adriatic (Tronto, Pescara, Sangro, Trigno, Biferno) provide water for irrigation in their fertile lower valleys. The water level in these streams varies greatly according to seasons; and floods, due in large part to indiscriminate felling of timber on the higher slopes, are frequent. Cutting of the forests also contributes to the ever-present danger of landslides endangering roads and railroads. .Agriculture does not thrive on the shallow soils of most of the region and crop averages are low. Wheat is the main cereal crop; grapes and, tomard the Adriatic, olives and fruit are grown, while among industrial crops tobacco, sugar beet and saffron are of importance. Animal husbandry has long been the mainstay of a large part of the population, and migratory herding (transhumance) of sheep, from mountain pastures in the Abruzzi to the lowland winter pastures of the Foggia plain and of the Roman region, is still a feature of the economy. Pigs are raised in large numbers. and hams and sausages of the Xbruzzi are well known. Industrial development has been negligible except for food industries and artisan work on a small scale. The main rail artery is the Rome-Pescara line, crossing the central part of the region, connecting Rome with the Abruzzi and with the Adriatic. Lines of local importance include those connecting Sulmona with L'Aquila and Terni to the north, with Venafro and Campobasso to the south, as well as the lines from Campobasso to Benevento and to Termoli on the Adriatic. Important cities are the provincial capitals L'Aquila, Campobasso, Chieti, Pescara and Teramo.

The region had long resisted conquest and retained its own character even after Roman rule was imposed on it. During the early middle ages all of it came under the Lombards, the Abruzzi being controlled by the duchy of Spoleto, and Molise by the duchy of Benevento. The Normans established themselves in the Xbruzzi during the 12th century, and the region sided with the Hohenstaufens during their long struggle with the papacy. After the fall of the Hohenstaufens, the region came under the Angevin, Spanish and Bourbon rulers of the kingdom of Naples (divided as Abruzzo Ulteriore I, Abruzzo Ulteriore II, Abruzzo Citeriore and Molise) and became part of the united Italian kingdom in 1860. Among the natives of the region are two of the great writers of modern Italy, Gabriele D'Annunzio and Ignazio Silone. In the field of the fine arts, while the Abruzzi retain a few Roman monuments, their period of greatest development was the 12th–14th centuries, and cathedrals, churches and abbeys bear witness to the flowering of Romanesque and Gothic architecture and sculpture. (G. KH.)

ABSALOM, the third son of David (*q.v.*) and his father's favourite. The picture presented in II Sam. xiii–xix (which deals mainly with his life) suggests that he was the Alcibiades of the Old Testament, alike in his personal attractiveness, his lawless insolence and his tragic fate. He is first mentioned as murdering his half brother Amnon, David's eldest son. in revenge for the rape of his full sister Tamar. For this deed he was driven into banishment, but he was eventually restored to favour through the good offices of Joab. Later, when some uncertainty seems to have

arisen as to the succession, Absalom organized a revolt. For a time he seemed to be completely successful; David with a few followers and his personal guard fled across the Jordan, leaving to Absalom Jerusalem and the main portion of the kingdom. The usurper pursued the fugitives with his forces but was completely defeated in "the forest of Ephraim" (apparently west of Jordan) and killed by Joab, who found him caught by the hair in an oak tree. To the affectionate chivalrous heart of David, the loss of his son, worthless and treacherous as he was, brought grief which more than outweighed his own safety and restoration.

ABSALON (c. 1128–1201), Danish archbishop and statesman prominent in public affairs under Kings Valdemar I and Canute VI (*qq.v.*), was a younger son of Valdemar's foster-father Asser Rig and belonged to the powerful Hvide family of Zealand. After studying in Paris, he returned to Denmark in 1156 and sided with Valdemar in his struggle for the kingdom. After Valdemar's victory at Grathehede (1157), Absalon in 1158 was made bishop of Roskilde. Thereafter he was the king's closest adviser. In opposition to Archbishop Eskil (*q.v.*), he approved the king's support of the emperor Frederick I Barbarossa in his dispute with Pope Alexander III and also Valdemar's oath of fealty to the emperor. By 1167, however, Absalon and the king were reconciled to the pope and were aiming at independence from the emperor.

Absalon directed the building of the fortress of Havn (Copenhagen) and compaigned vigorously against the pagan Wends of the north German coast, whose base on Riigen was captured in 1169. Its incorporation, with papal permission, into Absalon's diocese marked the beginning of Danish supremacy in northern Germany.

Valdemar's claim to rule by divine right received papal sanction in 1170 when his father, Canute Lavard, was canonized and his son Canute VI was crowned as joint king, and Absalon was undoubtedly the author of this policy. Elected archbishop of Lund in succession to Eskil in 1177, Absalon combined Lund with Roskilde till 1192. His zeal for discipline, however, provoked a rising in Skaane when he became archbishop. As guardian of Canute VI, he prevented the renewal of the oath of fealty to the emperor after Valdemar's death (1182) and in 1184 won a decisive victory over a German fleet. He founded many churches in Skaane and Zealand, generously endowed his family's abbey at Soro and, during his last years, tried to unify Danish ecclesiastical procedure. He died at Soro in 1201. Saxo Grammaticus (*q.v.*), whose patron Absalon was, glorifies him as a hero, but modern historians tend to estimate Absalon's achievement less highly.

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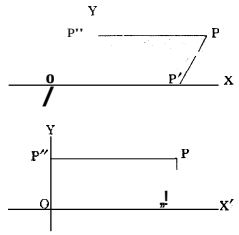
ABSAROKA, a range of mountains immediately to the east of Yellowstone National park in northwestern Wyoming. The range extends about 170 mi. in a northwest-southeast direction and has a width of 84 mi. Mid-Tertiary volcanic action built up a great plateau in the area. This volcanic accumulation was then uplifted and streams cut deep canyons into the plateau surface. Mountain glaciers have scoured the eroded surface and the resulting features are most spectacular. The upland surfaces (10,000–12,000 ft. above sea level) rise from 2,000 to 4,000 ft. above Yellowstone park and 5,000–6,000 ft. above the Bighorn basin to the east. (H. B. HA.)

ABSCESS, a localized collection of pus in tissue spaces, hollow organs or body cavities. It is formed as the result of infection with pus-forming (pyogenic) organisms; there is local heat, redness, swelling and pain. The cells die and the centre of the inflammatory mass liquefies to form pus, which may break through the wall of the abscess or be emptied by incision. Various names are applied according to the location and the causative organism. The term "cold abscess" designates a localized collection of pus caused by the bacillus of tuberculosis. See BACTERIAL AND INFECTIOUS DISEASES; INFLAMMATION. (F. L. A.)

ABSCISSA. In Cartesian co-ordinates (see ANALYTIC GEOMETRY) the abscissa of a point (P) is the part (OP') of the X axis lying between the origin (O) and the point (P') where a line (PP') parallel to the Y axis cuts the X axis. In each of the two figures, the line segment P″P is also called the abscissa of P. The axis of



X (OX) is called the axis of abscissas.

ABSENTEE OWNERSHIP, a term originally used to describe the ownership of land by proprietors who did not reside on the land or cultivate it personally but enjoyed income from it. The term "absentee ownership" has come to have a social connotation not inherent in its literal meaning, based on the assumption that absentee owners lack the personal interest in and knowledge of their lands and tenants.

The fact of absentee ownership has been a social and political issue for centuries in many parts of the world. It was an important criticism directed at the absentee owners among the court nobility in prerevolutionary France, and it was a prominent issue in the debates concerning the alleged exploitation of Irish tenants by English absentee owners in the 19th century. It remains an issue in the numerous programs for land reform in many countries.

Early in the 20th century, Thorstein Veblen, the U.S. economist, also applied the term to owners of huge industrial combinations. He argued that, through their control of vast enterprises, they exercised control over industrial prices and output while not themselves engaging in industrial pursuits.

See T. Veblen, *Absentee Ownership and Business Enterprise in Recent Times* (1923); *E.* Roll, *A History of Economic Thought,* rev. ed. (1942). (FK. L. K)

ABSENTEE VOTING. A system designed to permit the use of their vote to persons unable to appear at the polling place where they are registered by reason of their state of health, occupation, etc. Special administrative safeguards are necessary to assure the secrecy and legitimacy of absentee ballots; in practice, these keep some eligible persons from voting and have, in certain instances, involved some discrimination along party lines. The basic provisions are few, although arrangements vary in detail from country to country. (X.)

United States.—Absentee voting in the United States was first provided for by state legislation during the Civil War, when 11 Union states permitted men serving in the Union army to vote in the federal election by absentee ballot or by proxy. There were then about 2,000,000 men under arms, of whom about 150,000 voted. But although more than three-fourths of the soldiers voted for the re-election of their commander in chief, Pres. Abraham Lincoln, their total vote scarcely affected the general outcome. There was relatively little interest in the soldier vote during the Spanish-American War or World War I. During the latter, some legislation was discussed, but no action was taken and the war department announced that there would be no voting overseas. It did, however, co-operate with those states which provided machinery for absentee voting within the U.S.

The first use of the absentee ballot by civilians was authorized by a Vermont law passed in 1896, and five years later a similar measure was adopted in Kansas.

Between 1917 and 1942 the number of states which extended this privilege to their citizens increased from 28 to 45. By the 1960s all states had established a system of absentee voting. Military personnel were permitted to vote by absentee ballot by all states, but, except for this common characteristic, great diversity existed in state absentee voting laws. Some states permitted any absent qualified voter to cast an absentee ballot. Others restricted the privilege to those engaged in certain duties, businesses or occupations. Some variation existed, too, in the types of elections in which absentee voting was authorized. The most restrictive laws limited the exercise of the privilege to elections for national office. At the other extreme, some states allowed it in all elections.

The trend has been toward extension and liberalization of the privilege of absentee voting. Many states have authorized the use of an absentee ballot by the physically incapacitated, whether they are located within or outside the state.

World War II experience showed the inadequacy of arrangements for absentee voting in time of war. Late in 1942 a Soldiers

Vote law was passed by congress to facilitate voting, but under its provisions only 28,051 votes were cast for members of congress in that off-year election. For the presidential election of 1944 the law was revised to provide a federal ballot for citizens of such states as approved its use, and then only if the serviceman had applied for a regular state absentee ballot by Sept. 1 and had not received it by Oct. 1. Twenty states approved the use of this ballot. About 2,800,000 servicemen, an estimated 30% of the total number of voting age, cast absentee ballots, state or federal, in this election.

The federal legislation and many of the state laws facilitating absentee voting by service personnel were temporary measures, which expired when peace was restored after World War II. As the presidential election of 1952 approached, with millions of Americans again in uniform, Pres. Harry S. Truman recommended that state laws be revised to remove obstacles to voting by absent military personnel. The president further recommended that a federal ballot be made available to servicemen from states which failed to make adequate provision for absentee voting, but congress failed to act on these recommendations. The defense department estimated that only 15% of the servicemen of voting age voted by absentee ballot in that election.

In the national election of 1956, by contrast, 35% of servicemen of voting age voted, although among the civilian population a smaller percentage of potential voters cast ballots in 1956 than in 1952. Instrumental in bringing about this change were the enactment of the Federal Voting Assistance act of 1955 by the congress and a general revision of state laws on the subject to enlarge the opportunities for absentee voting by removing such obstacles as tardy mailing of ballots to voters, the requirements of personal registration and payment of poll tax. (W. B. PT.)

Great Britain, the Commonwealth and Europe.—The British Labour government's Representation of the People act of 1948 made eligible for a postal vote: (1) persons certified by a doctor as too ill to appear at a polling booth; (2) persons who would otherwise have to make a journey by sea or by air to reach a polling station; (3) persons who have moved from one electoral registration district to another since the register was compiled; (4) persons away from their place of voting on polling day by reason of their occupation. A proxy vote was allowed to servicemen, government employees and their dependents if they were outside Britain on election day. Few persons have claimed proxy votes, except at the 1918 and 1945 general elections. British law does not make provision for persons who are absent from their electoral district on vacation. It also discriminates against persons who have moved distances of up to 15 mi. within large cities; although they may have changed their constituency, they cannot have a postal vote since large cities are technically single registration districts.

Applicants for the postal vote in Great Britain must file their claim with the election officials for their place of registration at least nine working days before the election; often they do so at the behest of party canvassers. A postal ballot is then issued to them, along with a ballot-paper envelope (bearing on the outside the number of the ballot paper) and an identity form which must be countersigned by someone personally acquainted with the voter. Ballots must be returned by polling day; the election officials verify that the identity forms and the ballot-paper envelopes bear the same numbers and are properly filled out. The two are separated, the ballot envelopes opened and the postal votes then counted. Proxy voting requires an intending voter to nominate a proxy on an official form; the nominee then appears at the polling station with a certificate issued by the registration officer to substantiate his claim to cast a proxy vote.

The largest postal vote in Britain up to mid-20th century was in 1951 when 2.6% (742,000) of the total vote was so cast. In the 1959 election 692,000 postal ballots were issued of which 612,000 were returned; of these, 13.000 were invalidated. usually for lack of a witness's signature. The number of such votes varied from a minimum of 113 to a maximum of 4,069 in individual constituencies; it was usually higher in sprawling rural seats. and lower in compact urban ones.

In close elections the postal vote has been of considerable political importance, because in almost every constituency the Conservatives have obtained well over half of it. Since postal voting figures are not officially announced, one must rely upon the estimates of people present at the count. The authors of *The British General Election of 1959 (see Bibliography)* calculate that at that election, if the postal vote be reckoned at three to one in favour of the Conservatives it may be deemed to have won them 11 seats. At a minimum, with the vote divided only six to four in the Conservatives' favour, it accounted for five of their victories. The Labour party's special effort to increase its postal vote at this election apparently had little success. Observers attribute the Conservatives' advantage partly to their superior political organization and partly to the fact that the postal vote seems to be more readily claimed by educated persons and that such are more likely to vote Conservative. Similarly, in the general election of 1957 in the German Federal Republic the party of the better educated, the Christian Democratic Union, secured 60.3% of the 1,537,000 postal votes, although it obtained only 49.6% of the votes cast in person.

Because the proper use of absentee voting facilities is related to education, in parts of the commonwealth where illiteracy is fairly widespread absentee voting is either not allowed, as in Nigeria and Uganda, or allowed only on a severely restricted basis, as in India, Malaya and Jamaica. But in highly literate Australia, where voting is compulsory, generous provisions are made for the casting of absentee votes; there is also an election officer in London to aid Australians in the United Kingdom to vote in Australian federal elections. Where qualifications for electors are not primarily geographical, the postal vote may be the normal form of voting. Such is the case in the voting for the university representatives in the house of commons of Northern Ireland and for the university seats in the senate of the Republic of Ireland In some European countries where elections are held on Sundays, persons traveling for pleasure are permitted to cast their votes at polling places other than those where they are registered, provided that they have first obtained a certificate from the election officials. Normally the voter, even though voting away from home, must cast his ballot for candidates in his constituency of registration.

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ABSINTHE is a flavoured spirit and not, strictly speaking, a liqueur. It is yellowish-green in colour. dry and bitter, and of very high alcoholic strength, being 68% alcohol by volume. Its predominating ingredient is wormwood *(Artemisia absinthium)*, but hyssop, fennel, aniseed, liquorice, angelica root, sweet flag, dittany leaves and star-anise fruit are also used. These herbs are found in the Val de Travers in the Swiss Jura.

Henri Louis Pernod first made absinthe commercially in 1797, after he had bought the recipe from Dr. Ordinaire of Couvet, Switz., but because of the danger to public health its manufacture was prohibited in Switzerland in 1908, in France in 1915 and, later, in other countries including the United States. Wormwood is habit-forming and can cause delirium, hallucinations and even permanent mental deterioration In 1918 Pernod Fils (Sons) built a factory at Tarragona, Spain, where they imported the necessary herbs, but this was closed down at the time of the Spanish Civil War (1936–39). Since then only imitation absinthe has been obtainable; it is usually made out of aniseed and contains no wormwood. (C. C. H. F.)

ABSOLUTE. The term has two chief uses: as an adjective it is used in contrast with relative, comparative or conditioned; as a noun it is used by philosophers to denote the universe conceived as a single whole or system.

Absolute v. Relative, etc.—1. Sometimes the contrast is between what stands in a certain relation and what does not. Thus the term teacher is described by traditional logic as relative be-

cause its meaning involves relation to a pupil; similarly, pupil is relative because it involves the relation to a teacher. But table and boulder are absolute terms because they do not refer to their objects as standing in any special relation. It has proved difficult at times to be sure whether a term is absolute in this sense or not. For example, are space, time and motion absolute or relative? Newton maintained that they were both. The space, time and motion of ordinary perception were relative, since the position of everything for it was determined by relations to other things; but there were also an absolute space, time and motion in which, for example, a thing would have a position even if there were no other thing in the universe. This absolute view was rejected by Albert Einstein, who held that when we speak of a position, a moment or a motion, relations to other things enter into the very meaning of the term; and this view has come to prevail.

2. Sometimes the term absolute refers to what has reached the extreme limit within its own kind, so that no further improvement or advance is possible. Thus the propositions of mathematics are said to be absolutely true, while most other propositions are conceded only varying degrees of truth or probability; and absolute zero is the temperature at which the motion of particles which constitutes heat would reach complete rest; a more intense physical cold is inconceivable.

3. Closely connected with this usage is a third, in which absolute means that which is without conditions or reservations. Thus absolute monarchy is a government in which the power of the monarch is subject to no conditions or limitations. In ethics an action such as truth-telling is called absolutely right, or an attitude such as love absolutely good, to indicate that the rightness or goodness does not depend on the conditions of any particular society, but holds independently and universally.

The Absolute.— Among philosophers the notion of an Absolute has been common since the time of Plato, but the term is chiefly associated with the German school of Absolute Idealism, whose leading members were Johann Fichte, Friedrich Schelling and Hegel. The simplest way of arriving at the notion of the Absolute is as follows: start with any object or event and ask what are its causes. Repeat the question about the causes themselves and again about their causes. One finds that one is carried in thought along a set of radiating paths, all of which lead out into infinity. Philosophers have been led through such reflections to the notion of a being with the following characteristics: (1) It is all-comprehensive; there could not, even in theory, be anything outside it; to suppose there could only shows that me have not been thinking of the whole. This ultimate whole is the Absolute. (2) Furthermore, it is conceived as an intelligible whole, which implies that if enough is known about it, it is not a mere aggregate of parts, but it is seen that every part is necessarily connected with every other. (3) From this it is held to follow that ordinary beliefs are not wholly true, nor the things of common experience wholly real. Just as one cannot understand what a stomach or a heart is until seen in its place in the organism as a whole, so one cannot see what anything finally is until seen in its place in the Absolute whole. Only the Absolute is fully real. (4) It is timeless or eternal. All time is included within it, but it is not itself subject to change. (5) It is *causa sui,* self-caused; for there can be no cause or ground outside itself. (6) By its leading exponent, Hegel, it was conceived as a conscious whole or mind, consisting throughout of experience, though whether it was to be regarded also as personal and to be identified with God was a matter of dispute. Some philosophers, for example, Josiah Royce, have maintained the Absolute to be morally good; others have followed Spinoza in holding it to be above all distinctions of value. Again, for some who have accepted the notion, such as Plotinus and F. H. Bradley, the Absolute was a seamless whole, above relations and distinctions of any kind, and hence could be grasped only by a superrational or mystical insight, while for others, of whom Plato was apparently one, its parts were related very much as are the propositions in a system of geometry.

Critics of the notion of an Absolute have taken various lines. Many have pointed out that history could hardly be, as Hegel held, a progressive realization of the Absolute if there were no real time or change and if the goal of the process were realized already. Others, such as Bertrand Russell, have insisted that not all present knowledge can be regarded as illusory appearance; if it is, this insight itself would have to be regarded as illusion. Others again have argued, with William James, that the world is a perfect whole neither logically nor morally and that belief in the Absolute is merely a "tender-minded" faith that the world is more rational than in fact it is.

See histories of philosophy by Wilhelm Windelband, Harald Hoffding, etc. Spinoza's *Ethics,* Hegel's *Phenomenology* of *Mind* and Bradley's *Appearance and Reality* develop the idea of an absolute in different ways; G. W. Cunningham, *The Idealistic Argument in Recent British and American Philosophy* (1933), considers the evidence pro and con. (B. Bd.)

ABSOLUTE DIFFERENTIAL CALCULUS: *see* VECTOR AND TENSOR ANALYSIS.

ABSOLUTE PITCH: *see* PITCH, MUSICAL.

ABSOLUTE TEMPERATURE SCALE, the scale of temperature based on thermodynamics, also called the Kelvin scale after Lord Kelvin (*q.v.*). The temperature scale derived from the law of expansion of a perfect gas is identical with this thermodynamical scale. The usual abbreviations for absolute scale are abs., A. or K. Comparing it (approximately) with the centigrade scale, 0° C. = 273° A., 100° C. = 373° A., thus absolute zero is equivalent to −273° C. *See* THERMODYNAMICS: *Thermodynamics and Physical Chemistry;* THERMOMETRY: *Modern Thermometry From 1920.*

ABSOLUTE UNITS, units of measurement of a physical quantity in terms of fundamental (arbitrary) units of length, mass and time. The implication of the word "absolute" is taken to mean that none of these units depends on variable factors that cannot be ruled out by the terms of their definition. The three absolute systems most commonly used are set forth in Table I for purposes of comparison.

TABLE *I.—Absolute Systems of Units, in Terms of Fundamental Units*

System	Abbreviation	Fundamental Units			Force	Conversion factor
		Length	Mass	Time		
Metric	c.g.s.	Centimetre	Gram	Second	Dyne	
Metric	m.k.s.*	Metre	Kilogram	Second	Newton	10^5 dynes
British	f.p.s.	Foot	Pound	Second	Poundal	1.38×10^4 dynes

*This system of units, because of its advantages in electrical measurements, came into increasing scientific use in the U.S.

Engineers frequently use systems of units in which weight replaces mass; *i.e.,* the force of the earth's gravitational attraction for an object instead of the object's inherent inertia. Since the weight of an object depends on its position because of the variation of gravitational attraction over the surface of the earth as well as everywhere in space, these engineering systems, according to the above criteria of invariance of the fundamental units, are not entitled to the name of absolute systems. For comparison with the above, however, these units and conversion factors are shown in Table II.

TABLE *11.—Engineering Systems**

System	Length	Force	Time	Mass	Conversion factor
English	1 foot	1 pound-weight	1 second	Slug	32.174 poundals
Engineering metric	1 centimetre	1 gram-weight	1 second	Metric slug	980.665 dynes

*If, and only if, by agreement, weight is defined as being measured where the acceleration of gravity is 980.665 cm./sec.^{2} can the above engineering systems be arbitrarily regarded as absolute, as indeed they often are

See also MECHANICS: *Newton's Laws; Physical Units; Weights and Measures.* (H. B. LM.)

ABSOLUTION, in religion, is the pronouncement of remission to the penitent. Interpretations of absolution in the several Christian traditions vary in relation to two issues, the designation of penance as a sacrament and the designation of the ministry as a priesthood (*see* MINISTRY, THE CHRISTIAN). In Roman

Catholicism, where penance is a sacrament and the minister is a priest, absolution grants release from the guilt of sin to the sinner who is truly contrite over his sin, confesses his sin to a priest and promises to perform satisfaction to God for the offense. The doctrine of absolution is similar in Eastern Orthodox teaching; but in place of the Western formula, "I absolve thee from thy sins in the name of the Father and of the Son and of the Holy Ghost," Eastern churches generally employ some such formula as "May God, through me, a sinner. forgive thee. . . ." In Anglican and in Lutheran usage, formulas of absolution have ranged from the declaratory "I forgive you all your sins" or "I forgive thee" in the Visitation of the Sick, to the precatory "Almighty God, have mercy upon you, and forgive you all your sins." Some Anglican writers distinguish three forms of absolution in the usage of that communion: declaratory, intercessory and judicial. In keeping with their doctrines of the ministry and of the sacraments, other Christian traditions have confined absolution to prayers for forgiveness and the announcement of God's willingness to forgive all those who truly repent of their sins; hence absolution is neither a judicial act nor a means by which the forgiveness of sins is conferred, but a statement of divine judgment and divine forgiveness. Nevertheless, some formula for the public confession of sins and the public pronouncement of forgiveness is included somewhere in the liturgies of most Christian groups, even of those that avoid the term absolution altogether. *See* also CONFESSION.

(J. J. PN.)

ABSOLUTISM, POLITICAL. In its general sense, absolutism means a governmental system in which power is wholly concentrated in a single ruling agency, typically a single individual. The essence of such a system is that the ruling power is not subject to regularized challenge or check by any other agency, be it judicial, legislative, religious, economic or electoral. Louis XIV, who ruled France during the late 17th and early 18th centuries, furnished the most familiar assertion of absolutism when he said, "L'état, c'est moi" ("I am the state"). Fascist, nazi and communist dictatorships provide more recent examples. In fact, all governmental systems described as dictatorial, despotic, autocratic, authoritarian or totalitarian are absolutist in their concentration of political power. By the middle of the 20th century, absolutism came to mean the opposite of western democracy, in which government is limited by free elections and often by other means of distributing power.

Varying in form, political absolutism has prevailed in much of the world over long periods of time. However, the form originating early in modern European history became the prototype. Its character was definitely monarchical, based on the strong individual leaders of new nation-states created at the breakup of the medieval order. The power of these states was closely associated with the power of their kings, and to strengthen both it was necessary to curtail the restraints on centralized government which had been exercised by the church, feudal lords and medieval customs generally. By claiming the absolute authority of the state against such former restraints, the monarch as head of state claimed his own absolute authority as well.

By the 16th century monarchical absolutism was coming to prevail in much of western Europe, and it was widespread in the 17th and 18th centuries. Besides France, whose absolutism was epitomized by Louis XIV, well-known illustrations may be drawn from Spain, Prussia and Tudor England.

Ideological Basis. — In defense of monarchical absolutism, the simplest argument was that kings derived their authority from God. This view could justify even tyrannical rule as divinely ordained punishment, administered by rulers, for man's sinfulness. In its origins, the divine right theory may be traced to the medieval conception of God's award of temporal power to the political ruler while spiritual power was given to the head of the church. However, the new national monarchs asserted their authority in all matters, and tended to become heads of church as well as state. Their power was absolute in a way that was impossible for medieval monarchs confronted by a church that was essentially a rival centre of authority.

More pragmatic arguments than that of divine right were also advanced in behalf of absolute monarchy. Complete obedience to a single will was said to be essential to order and security. The alternative was the chaos believed to flow from challenging or dividing political power. Efficiency in protecting life and property required absolutism. In so justifying submission by subjects on the ground of self-interest, the most elaborate statement was made in the 17th-century work the *Leviathan* by Thomas Hobbes. Technically Hobbes's theory allowed the absolute sovereign to be a representative assembly instead of a monarch, but he regarded an individual ruler as more convenient. In this respect, Hobbes resembles other defenders of absolutism. The single will to which they assign all authority ordinarily turns out to be that of a single man or of a very small group. The same has often tended to be the case even with those theorists who have started with the premiss that there is a "general will" of the whole community whose authority is absolute when expressed by a majority. Although Jean Jacques Rousseau, the 18th-century French writer who developed the conception of the general will, apparently meant its absolute authority to be exercised by the people themselves, it has readily been converted into a justification for strong leadership ruling absolutely in the name of the people.

20th-Century Forms. — The 20th-century forms of absolutism appear no different in this important respect. Although nonmonarchical in leadership, fascist, nazi and communist systems strongly personalized the absolute power claimed for the state or for the sociopolitical movement dominating the state. Concentration of power thus approximated that of the older absolutist forms, but the 20th-century dictatorships were innovative in that they made absolute political. authority virtually synonymous with society and accordingly more pervasive, or totalitarian, in its impact on the lives of individuals. Along with this went a much broader effort to manufacture popular support for absolute rulers than had been characteristic of the earlier monarchies.

Absolutism, especially in its later forms, is most clearly distinguished from democracy by contrasting the unlimited power claimed for dictators with the constitutional practices of democratic systems. The difference rests on more than the degree of popular support for governmental decisions. What is always absent in absolutism is restraint on the exercise of political power. No constitutional machinery exists to impose limits on what rulers may do. Not only are they unchecked by an electorate free to choose an alternative set of rulers. but they are conceived to be under no law or custom higher than their own will. Although absolutists are, in practice, likely to take some of their subjects' desires into account, if only as a means to maintain power, it is still true that law is a product of the will of the rulers alone. Furthermore this law of the rulers exhausts the meaning of justice in the absolutist state. No higher standard of right and wrong can be applied.

Nevertheless it is possible, and indeed frequent, for absolute rulers to claim that law as they make it is really based on some higher standard than that of their own will. From kings asserting that they represented God's will on earth to 20th-century leaders speaking in the name of a national, racial or class destiny, political absolutism cloaks itself in the language of philosophical absolutism.

The monopoly of political power is justified by a knowledge of absolute truth. Neither the sharing of power nor limits on its exercise appear valid to those who believe that they know, and know absolutely, what is right. *See* MONARCHY; *see* also Index references under "Absolutism, Political" in the Index volume.

(L. D. E.)

ABSORPTION OF LIGHT IN SPACE: *see* INTERSTELLAR MATTER.

ABSORPTION SPECTRUM: *see* SPECTROSCOPY: *Observations and Measurements;* LIGHT; MOLECULAR SPECTRA; SPECTROSCOPY, ASTRONOMICAL.

ABSTRACT AND ABSTRACTION. A number of things may be found to have some property or relation in common, to which an appropriate designation is then given. This procedure is commonly known as a process of abstraction. Thus, when it was discovered that certain bodies allow electricity to

flow through them, they came to be known as conductors, and the common property was called conductivity. The word "conductivity" is said to be an abstract term; and conductivity itself is said to be an abstraction. Some writers also call the concept of conductivity an abstract idea. Abstraction may also occur when observation of a single thing leads to detection of some property or relation which can be shared with other things. In this way, the discovery that a man's blood fails to clot might lead to the introduction of the abstract term "hemophilia."

"Abstract" is contrasted with "concrete" (though there is no corresponding opposite for the word "abstraction"). A word or expression is said to be concrete if it refers to a particular thing. Thus the expression "World War I" is concrete, while the word "war" is abstract.

It is hard to give a satisfactory definition of "abstraction," since its use generally presupposes an oversimple conception of how thinking proceeds It might be said that abstraction is a process in which consideration is given to some aspect or feature of a complex whole to the neglect of the remainder; but this statement is both too vague and too restrictive to cover all the cases in which abstraction is commonly said to occur.

In modern logic, the word "abstraction" has several more exact senses. For example, suppose a given relation R is transitive, symmetric and reflexive. And consider a class of objects, every two of which are connected by the relation R. Then to each such class there may be made to correspond a symbol, S_i Each S_i can then be said to have been given a "definition by abstraction." This sense was introduced by Giuseppe Peano, who used it in defining cardinal numbers.

"Functional abstraction" is used for the process of obtaining a function from a given formula containing a free variable. If **A** is a formula, the notation *"Ax [A]"* is employed for the function obtained from **A** by abstraction relative to **A**; *"Ax"* is called an *abstraction operator.* (The foregoing is Alonzo Church's notation, for which *see* bibliography; other logicians use different but equivalent notations.)

Other abstraction operators have been found useful. By prefixing the symbol *"$\hat{x}$"* to a propositional form containing a free variable *"x,"* we can refer to the class of things satisfying that propositional form. The symbol *"$\hat{x}$"* is called the *class abstraction operator.*. Again, by prefixing the symbol *"$\hat{x}\hat{y}$"* to a propositional form with the two variables, *"x"* and *"y,"* we can refer to the relation in extension corresponding to the propositional form in question; *"$\hat{x}\hat{y}$"* is the *relational abstraction operator.* The above technical devices can be regarded as instruments for sharpening the vague notions discussed at the beginning of this article.

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ABSTRACT ART defines the nonfigurative painting and sculpture of the 20th century. The trends of modern art toward a diminished importance of the subject gave significant emphasis to the purely abstract qualities of form, colour, line and surface, and abstract art is based on the proposition that these formal attributes have an intrinsic and sufficient beauty and expressiveness. Deliberately avoiding the use or concealing the identity of any recognizable form of reality, abstract art is a complete rejection of subject, a total reliance on aesthetic elements.

The exploitation of colour by Fauvism and of form by Cubism (*qq.v.*) gave impetus to the early experiments of Wassily Kandinsky. Working with the Blue Rider group in Germany, he produced his first nonrepresentational picture ("Abstract Watercolour") in 1910. In 1912 he published *Über das Geistige in der Kunst insbesondere in der Malerei (The Art of Spiritual Harmony),* interpreting painting as an abstract art, analagous to music, capable of expressing and conveying emotion. In 1913 Kazimir Malevich launched Suprematism, a movement based on the creative manipulation of squares, circles, triangles and crosses, from which Naum Gabo and Antoine Pevsner developed Constructivism, an experimental form of nonfigurative sculpture. In 1917, Piet Mondrian and Theo van Doesburg founded the Dutch periodical *De Stijl* to promulgate the theory of Neoplasticism, a derivative of Cubism. Mondrian, its chief exponent, using right angles, three primary colours and black, gray and white, evolved a compelling and distinctive art.

Between World Wars I and II nonfigurative art progressed hesitantly in uneasy partnership with Surrealism. but the wide appreciation of Mondrian's work, coupled with the influential teaching of Kandinsky, Paul Klee and László Moholy-Nagy at the Bauhaus (*q v.*), had a marked effect on architectural and industrial design. After World War II abstraction spread and confirmed its importance as a persistent, characteristic tendency of modern art. During the postwar years, prominent names linked with abstract art were Jean Arp, Alexander Calder, Hans Hartung, Franz Kline, Alberto Magnelli, Ben Nicholson, Jean Paul Riopelle, Jackson Pollock and Nicholas de Stael. *See* also PAINTING: *20th Century.*

BIBLIOGRAPHY.—W. Kandinsky, *The Art of Spiritual Harntony,* Eng. trans *by* M. *Sadler (1914); Herbert Read, Art Now* (1933); *Michel* Seuphor (ed.), *L'Art abstrait. Ses Origines, ses premiers Maitres* (1949), *Dictionnaire de la Peinture abstraite* (1957) and *Piet Mondrian* (1958). (F. W. W.-S.)

ABSTRACT OF TITLE, a chronological summary of the essential portions of all documents such as deeds, mortgages, releases, bankruptcies, judgments, probates, tax liens and other records which affect the title to a parcel of land. In England the summary of the chain of title from a remote grantor is made from an examination of the original documents passed from grantor to grantee but in the United States it is obtained by a search of the public records *(see* TITLE TO LAND). This summary, usually prepared by a professional abstractor who may or may not be a lawyer, does not of itself disclose the state of the title but summarizes the evidence from which a title-examining attorney may draw legal conclusions. In large urban areas, abstracts of title have been superseded by title insurance *(see* TITLE INSURANCE COMPANY). (A. DM.)

ABSTRACTS. An abstract is a complete citation and condensation or summary of essential facts. theories and opinions presented in an article or book. It is frequently published at the beginning of an article or in an abstracting journal. The ideal abstracting journal is noncritical. covers its field completely, maintains a high quality in its abstracts, is prompt in its publication of the summaries and prints good annual and collective indexes. The cumulative index covering several years is a great timesaver for the busy researcher.

Almost every field of knowledge has its abstract journal. There is a list of these in the *Index Bibliographicus,* compiled by Theodore Besterman. UNESCO, 2 vol. (1951–52). The latest edition of *Ulrich's Periodicals Directory* also has a list of over 175 titles.

The first abstracting journal, the *Pharmaceutisches Centralblatt* (later the *Chemisches Zentralblatt*), started in 1830, is still being published. This was followed by the *Quarterly Journal* of the Chemical society, now the *British Chemical Abstracts.* Abstracts appeared in it in 1871. Since then there have been many abstracting periodicals, mostly in the scientific fields. *The Zoological Record* began in 1864; the famous *Chemical Abstracts* in 1907; *Biological Abstracts* in 1926; *Psychological Abstracts* in 1927; *Nutrition Abstracts* in 1931; *Gas Abstracts* in 1945; *Fuel Abstracts* in 1947; and *Nuclear-Science Abstracts* in 1948.

Chemical Abstracts is one of the best known of the scientific abstracts. Started in 1907 by the American Chemical society to replace the *Review of American Chemical Research* (1895–1906), it describes and indexes about 75,000 articles and 10,000 patents annually. About 1,500 part-time abstracters prepare most of the abstracts. There are 7,000 journals entered in the *List of Sources Searched for Abstracts* (1956). Decennial indexes have been published since 1906.

In the early 1950s the social sciences put forth some abstracting journals, such as the *International Social Science Bulletin* (1949–), under the direction of UNESCO; the *International Political Science Abstracts* (1951–), edited by the International Political Science association; *Sociological Abstracts* (1952–), published in New York; and *Economic Abstracts* (1953–

), published at The Hague.

A large amount of scientific research is published in foreign languages. Abstracts are usually written in English. so that the reader may know easily whether he needs the article in the original language or in translation. Complete copies of the article may be read in the larger scientific libraries, or photostatic or microfilm copies may be secured from the Library of Congress or other large libraries.

The Special Libraries association sponsors a translation centre, located in the John Crerar library in Chicago, which serves as a depository for translations contributed or loaned by government agencies, scientific societies, industrial concerns, universities or other similar organizations.

At mid-20th century, scholars and librarians felt there was too much overlapping among abstracting and indexing services. There was also considerable interest in the possibilities of machine searching for information, which resulted in several conferences, starting with the Royal Society Scientific conference of 1948 which discussed at length the problem of abstracts.

See also LAW REPORTS; ABSTRACT OF TITLE.

See S. C. Bradford, *Documentation,* 2nd ed. (1953). (W. V. N.)

ABU, MOUNT, a mountain near a town of the same name, is just within the southern border of Rajasthan, India, 110 mi. N. of Ahmedabad. It is an isolated feature of the Aravalli range, detached from the chain by a valley seven miles across, in which flows the Western Banas. It rises from the surrounding plains like a precipitous granite island, its several peaks ranging in height from 4.000 to 5,650 ft. The hill has been a place of pilgrimage for at least 2,000 years, and is mentioned as such in the *Mahabharata* where it appears as Arbuda. The elevations and platforms of the mountain are covered with elaborately sculptured Jain shrines, temples and tombs. On the top is a small round platform containing a cavern, with a block of granite bearing the footprints of Data-Bhrigu, an incarnation of Vishnu. The two principal temples, at Dilwara, about the middle of the mountain, are built of white marble and are pre-eminent both for their beauty and as examples of the culminating baroque phase of Gujarat architecture.

The more modern of the two, the Tejpal temple, was built by two brothers, rich merchants, between 1197 and 1247, and for delicacy and richness of carving and minute beauty of detail, especially of the elaborately worked underside of its famous dome, it stands almost unrivaled. The other was built by Vimala, a local governor of the Solanki monarch, apparently about A.D. 1032; simpler and bolder in style, it is one of the oldest, as well as one of the most complete, examples of Jain architecture known. The principal object within the temple is a cell lighted only from the door, containing a seated figure of Parswanath, the 23rd *tirthankara,* or sage, of the Jain faith. The portico is composed of 48 pillars, the whole enclosed in an oblong courtyard about 140 ft. by 90 ft., surrounded by a double colonnade of smaller pillars, forming porticos to a range of 52 cells, each of which is occupied by an image of Parswanath. According to legend the Agni Kula (Fire-group) Rajputs originated in a fire pit around Mount Abu. This seems to represent a purgation rite by which the taint of foreign extraction of these Rajput clans was removed.

The town of MOUNT ABU (pop. 1951, 4,439), a much frequented hill resort, was the headquarters of the Rajputana states agency under British rule.

See C. E. Luard, *Notes on the Dilwara Temples and Other Antiquities of the Sacred Mount of Arbuda (Abu) (1913).*

ABU-AL-ALA AL-MAARRI (Arab. ABU-AL-'ALA' AL-MA-'ARRI) (973–1057), Arab poet and man of letters whose two famous collections of poems. *Saqt al-Zand* ("The Tinder Spark") and the *Luzumiyyat,* place him in the first rank of Arab poets. He belonged to the south Arabian tribe Tanukh, a section of which had migrated to Syria before the time of Islam. Born at Ma-'arrat al-Nu'man in north Syria. he was blind from early infancy as a result of smallpox. In 1007 he visited Baghdad and made the acquaintance of literary circles. but returned in 1009 to Ma-'arra, where he spent the rest of his days, until his death in 1057, in teaching and writing.

Apart from poetry. he wrote a volume of epistles on various literary and social subjects *(Mukatabat),* another of literary homilies, *al-Fusul wal-Ghayat* ("Chapters and Aims"), and a work on literary criticism in the unusual form of a description of a celestial journey, entitled *Risalat al-Ghufran* ("Epistle of Pardon"). The second collection of his poems, known as *Luzum ma lam yalzam* or the *Luzumiyyat* (a word meaning literally "necessities," descriptive of their complicated rhyming system), contains the more original, mature and pessimistic thoughts of the author in contemplating human life and death. Much interest has been shown in the author and his works by 20th-century scholars.

BIBLIOGRAPHY.—R. A. Nicholson, *Studies in Islamic Poetry,* with Eng. trans. of more than 300 poems from the *Luzumiyyat* (1921), his summary, with a partial Eng. trans., of the *Risalat-al-Ghufran* is in the *Journal of tha Royal Asiatic Society* (1900 and 1902); A. Rihani, *The Luzumiyyat of Abu'l 'Ala',* Eng. trans. (1920); D. S. Margoliouth, *The Letters of Abu'l 'Ala' oi Ma'arrat Al 'Nu 'man,* with Eng. trans. and biography (1898), and "Abu-al- 'Ala' al-Ma'arri's Correspondence on Vegetarianism" in *Journal of the Royal Asiatic Society* (1902); Ibrahim al-Arabi, Arabic ed. of the *Luzumiyyat* (1952); Taha Husscin and Ibrahim al-Abyari, *Sharh Luzum ma lam Galzam, a* commentary (1954). The *Saqt al-Zand* and *Risalat al-Ghufran* were published in Arabic in 1924 and 1950 respectively.

See also C. Brockelmann, *Geschichte der arabischen Literatur,* suppl. vol. i (1937).

ABU-AL-ATAHIYAH (ABU'L-ATAHIYA; Arab. ABU ISHAQ ISMA'IL IBN QASIM AL-'ANAZI) (748–828) was the first Arab poet of note to break with the conventions of the older poetry of the desert. and to adopt the simpler and freer language of the towns. Born at 'Ain al-Tamr on the Euphrates in 745, he was descended from clients *(i.e.,* loosely attached members) of the tribe of Anaza. His life was spent in Kufa and Baghdad, where he died in 828. during the reign of al-Ma'mun. In earlier life he wrote love lyrics. but his fame rests on the ascetic poems of his later years. the *Zuhdiyyat* (German translation by O. Rescher, *Der Diwan des Abu'l Atahija: Teil 1. Die Zuhdiyyat,* 1928), most of nhich are concerned with the observation of common life and mortality and are generally pessimistic in tone. In spite of this, and of suggestions of heresy in his verse. he was a favourite at the court of Harun al-Rashid. His poems were collected in part and published in Arabic (1887; reissued 1909).

On his position in Arabic literature *see* W. Ahlwardt, *Diwan des Abu Nowas* (1861); R. A. Nicholson, *Literary History of the Arabs* (1907; reissued 1953).

ABU-AL-FARAJ AL-ISFAHANI (ABU'L FARAT; Arab. ABU-AL-FARAJ 'ALI IBN AL-HUSAIN AL-ISFAHANI) (897–967), Arab scholar, was the author of *Kitab al-Aghani* ("Book of Songs"), which gives an account of the chief Arabic songs known in his day, with the stories of the composers and singers. Born in Isfahan in 897, he was a member of the tribe of the Quraish (Koreish) and a direct descendant of Marwan, the last of the Omayyad caliphs who ruled at Damascus and were deposed and succeeded by the Abbasid caliphs in 750. He was thus connected with the Omayyad rulers in Spain. and seems to have kept up a correspondence with them and to have sent them some of his works. He spent his youth and made his early studies in Baghdad (the capital of the Abbasids), becoming famous for his knowledge of early Arabian antiquities. His later life was spent in Aleppo with Saif-al-Dawla (to whom he dedicated the *Kitnb al-Aghani*), in Rai with the Buyid vizier Ibn Abbad, and in other cities in Moslem Arabia. In religion he was a Shiite and wrote a book on the martyrdom of the house of 'Ali, *Maqatil al-Talibiyyin,* but his fame rests on the *Kitab al-Aghani* which contains a mass of information as to the life and customs of the early Arabs, and is the most valuable authority for their pre-Islamic and early Moslem days. In the last years of his life he lost his reason. He died at Baghdad in 967.

The text of the *Kitnb al-Aghnni* was published in 21 vol. (1905–06). *See* also *Tables alphabétiques du Kitab-al-Agani,* a volume of elaborate indexes edited by I. Guidi (1900).

For his life *see* M'G. de Slane's French trans. of Ibn Khallikan's biographical dictionary (1843–71).

ABU BAKR (c. 573–634): later known as al-Siddik (the truthful, the upright, or the one who counts true). was the first Muslim caliph, reigning from 632 to 634. Of the Taim clan of the

tribe of Quraish at Mecca, he was a merchant, probably in a small way, when he became a friend of Mohammed before the latter's call to preach. He is usually said to have been the first male convert to Islam; but this may only reflect his later position. Before the Hegira (Mohammed's migration from Mecca to Medina, A.D. 622), he was clearly marked out as second to Mohammed by the latter's betrothal to his young daughter 'A'isha and by Abu Bakr's being Mohammed's companion on the journey to Medina. He had spent most of his wealth to promote Islam by ransoming believing slaves and in other ways. From 622 to 632 he was Mohammed's chief adviser, but had no prominent public functions except that he conducted the pilgrimage to Mecca in 631 and led the public prayers in Medina during Mohammed's last illness.

On Mohammed's death (June 8, 632), Abu Bakr succeeded to his political functions by the choice of the Muslims of Medina, with the title of *khalifat rasul-Allah* ("deputy or successor of the Messenger of God," or caliph). His caliphate was occupied with suppressing the risings in various parts of Arabia known as the *ridda* ("apostasy"), in which, despite the religious description, politics were probably uppermost. His chief opponent, Musailima, was killed at a battle in eastern Nejd in May 633. While clearing operations went on, Abu Bakr began to direct expansionist moves from Arabia into Iraq and Syria. The Muslim conquests had thus begun before his death (Aug. 23, 634). The ascription to him of the first "collecting" or writing down of the Koran is probably mistaken. *See* CALIPHATE. (W. M. WT.)

ABUKIR: *see* ABU QIR.

ABU 'L-FARAJ (13th century): *see* BAR-HEBRAEUS.

ABU'L-FAZL 'ALLAMI (1551–1602), secretary, historiographer, general and, in religion, tutelary genius of the great Mogul emperor Akbar. Born at Agra on Jan. 14, 1551, the second son of Shaykh Mubarak Nagauri and younger brother of the poet Fayzi, Abu'l-Fazl was presented to Akbar in 1574. A mystic and scholar, critical of the orthodox Moslem religious teachers, he assisted in the development of Akbar's eclectic *Din-i-Ilahi* ("The Divine Faith"). Appointed a military commander in the Deccan in 1599, Abu'l-Fazl distinguished himself there as a soldier and an administrator. He was assassinated at the jealous instigation of Akbar's eldest son, Salim (afterward the emperor Jahangir), on Aug. 22, 1602.

In Mogul Persian literature Abu'l-Fazl is famed for his *Akbarnama* ("Book of Akbar"), a history of Akbar's reign to 1601 supplemented by the *A'in-i-Akbari* ("Akbar's Institutes"), a "gazetteer" of the administrative and military organization and the social and religious life of Akbar's empire. Two collections of Abu'l-Fazl's letters are also extant.

See C. A. Storey, *Persian Literature: a Bio-bibliographical Survey*, vol. i, pt. ii (1954). (P. H.)

ABULFEDA (ABULFIDA; Arab. ABU-AL-FIDA' ISMA 'IL IBN 'ALI 'IMAD-AL-DIN) (1273–1331), Arab prince, historian and geographer, best known for his *Mukhtasar Tarikh al-Bashar* ("Abridgement of the History of the Human Race"), extending from the Creation to 1329. He was born in 1273 at Damascus, whither his father, Malik al-Afdal, brother of the prince of Hamah, had fled from the Mongols. He was a descendant of Ayyub, the father of Saladin. In 1285 he was present at the assault of a stronghold of the Knights of St. John, and he took part in the sieges of Tripoli, Acre and Qal'at al-Rum. In 1310 he was appointed governor of Hamah by the Mameluke sultan Malik al-Nasir. In 1312 he became prince with the title Malik al-Salih, and in 1320 received the hereditary rank of sultan with the title Malik al-Mu'ayyad. For more than 20 years he reigned in tranquillity and splendour, devoting himself to the duties of government and to the completion of the works to which he is chiefly indebted for his fame. *Taqwim al-Buldan* ("Geography of Countries") was founded on the works of his predecessors, and so ultimately on the work of Ptolemy. Parts of the work were published and translated as early as 1650. He was a munificent patron of men of letters, who came in large numbers to his court. He died at Hamah in 1331.

The text of *Mukhtasar Tarikh al-Bashar* was published in 1869. There are translations of parts into Latin, French and English. The *Taqwim al-Buldan* was edited by M'G. de Slane and M. Reinaud (1840), and translated into French, with introduction by M. Reinaud and S. Guyard (1848–83).

See C. Brockelmann, *Geschichte der arabischen Literatur*, vol. ii, (1902).

ABUL KASIM (Arab. ABU-AL-QASIM KHALAF IBN-ABBAS AL-ZAHRAWI; Lat. ALBUCASIS) (*c.* 936–*c.* 1013), a distinguished Arabo-Spanish physician, was born of Spanish parents about 936 at El-Zahra near Córdoba. His medical reputation was brought to the attention of Caliph Abd-ar-Rahman III (912–961), who named him as his court physician. He died about 1013.

Abul Kasim's magnum opus was his *Altasrif*, a comprehensive work devoted to medicine and surgery and divided into 30 parts. His surgical tract, which was translated into Latin by Gerard of Cremona, was the leading textbook on surgery in Europe for about 500 years. The material of the *Altasrif* was borrowed from the *Epitome* of Paul of Aegina (*q.v.*), but it eclipsed the *Epitome* and also the *Kitab al-Mansuri* of Rhazes because of its lucid descriptions and its remarkable illustrations of surgical instruments. Abul Kasim was not followed to any great extent by the Arab physicians, who favoured Rhazes and Avicenna (*qq.v.*) as medical teachers. His chief influence was in Latin Europe, where his lucidity and method of presentation were preferred even over Galen. More than anyone else, Abul Kasim helped raise the status of surgery in Christian Europe.

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ABU'L QASIM MANSUR: *see* FIRDAUSI.

ABUL WEFA (ABUL WAFA) (940–997/998), Persian astronomer and one of the greatest Moslem mathematicians, was born in Buzjan (now Buzdschan), Quhistan (now Khurasan), in 940, and flourished in Baghdad where he died in 997 or 998. He translated and commented on the works of the Greek mathematicians and made an exhaustive commentary on Diophantus, but these writings are lost; a book of applied geometry is probably the work of a pupil. He did not, as is sometimes claimed, discover the inequality in the moon's motion later called variation. He contributed much to the development of trigonometry, being probably the first to prove the generality of the sine theorem for spherical triangles; devised a new method for calculating sine tables; studied the tangent, drew up a table of tangents, and introduced the secant and cosecant.

See F. Woepcke in *Journal Asiatique* (1855); G. Sarton, *Introduction to the History of Science*, vol. i (1945). (D. McK.)

ABUNÁ, a river in Bolivia, rising east of the Cordillera Vilcabamba and flowing northeast for about 200 mi. to join the Madeira. Rubber, Brazil nuts, quinine and other forest products are the principal items of commerce in the densely forested and sparsely inhabited Abuná region. The Abuná constitutes the northern boundary between Bolivia and Brazil. (J. L. TR.)

ABUNDANTIA, Roman goddess, the personification of prosperity and good fortune. She appears holding a horn of plenty and distributing grain and money, or, in the aspect of Annona or Felicitas, almost exclusively on the coins, as representative of the personal power of the Roman emperor to induce prosperity. The numismatic representation occurs as early as Nerva and was especially popular under Antoninus Pius, Marcus Aurelius and Commodus. Because of the peculiarly single significance of the goddess she seems to have had no cult, unlike some other deified abstractions (*e.g.*, Clementia). Abundantia may be compared with Domina Abundia (O. Fr., Dame Habonde, Notre Dame d'Abondance), a beneficent fairy who brought plenty to those whom she visited (Grimm, *Teutonic Mythology*). (T. V. B.)

ABU NUWAS (ABU-AL-HASAN IBN HANI' AL-HAKAMI) (*c.* 756–810), who is recognized as the greatest Arab poet of his time, mas born about 756 in al-Ahwaz, Persia, of a Persian mother. His father nas a native of Damascus and a soldier. He is said to have spent a year with the Arabs in the desert to gain purity of language. He settled in Baghdad, where he enjoyed the favour of

the caliphs Harun al-Rashid and al-Amin, and died there in 810. Genial. cynical. immoral. Abu Nuwas drew on all the varied life of his time for the material of his poems. In his formal odes he followed on the whole the old Arab tradition, though with greater freedom than his predecessors, but his native genius probably found its best expression in the *Khamriyyat,* a famous collection of wine songs.

Abu Nuwas' collected poems were edited by M K Farid, *Diwan Abu Nuwas* (1932) The *Khamriyyat* was edited by W. Ahlwardt. *Diwan* des Abu *Nowas,* i. Die *Weinlieder* (1861).

See R *A* Nicholson, *Literary History* of *the Arabs,* pp. 292–296 (1907; reissued 1953).

ABU QIR (ABUKIR; ABOUKIR), a fishing village and summer resort on the Mediterranean coast of Egypt, 14½ mi. N.E. of Alexandria by rail. Pop. (1957) 10,224. The name means "Father Cyrus," who was a Coptic saint. From the protected anchorage the bay of Abu Qir smeeps eastward about 30 mi to the Rosetta mouth of the Nile. Behind this coast line lies the lagoon of Lake Idku, a former embayment of the sea. A fish-smoking plant operates there and a paper mill, making wrapping paper from rice straw. In the bay on Aug. 1. 1798, Horatio Nelson defeated the French fleet in the battle of the Nile, and near Abu Qir on March 8. 1801. a British army commanded by Sir R. Abercromby landed in the face of strenuous opposition from a French force entrenched on the beach. The site of the ancient city of Canopus (*q.v.*) is about 2 mi. from the village. (A. B M.)

ABU SIMBEL (IPSAMBUL), the name of a group of temples of Ramses II (c. 1250 B.C.) in Aswan province of Egypt (ancient Nubia), on the west bank of the Nile, 56 mi. S. of Korosko by river. The temples are hewn in the sandstone cliffs at the riverside. and are three in number. The principal one, probably the greatest and most imposing of all rock-hewn monuments, nas discovered by J. Burckhardt in 1812 and opened by G. B. Belzoni in 1817; the front was cleared several times, but the sand pressed forward from the north end. The hillside was recessed to form the façade, backed against which four immense seated colossi of the king, in pairs on either side of the entrance rise from a platform or forecourt reached from the river by a flight of steps. Of nobly placid design. the colossi are 65 ft. in height and are accompanied by smaller figures of Ramses' queen and their sons and daughters; behind and over them is the cornice. surmounted by a long row of apes. standing in adoration of the rising sun Large hieroglyphs just below the cornice give the titulary of Ramses II, who built the temple primarily for the solar gods Amon-Ra of Thebes and Ra-Horakhti of Heliopolis, the true sun-god; it is oriented to the east so that the rays of the sun in the early morning penetrate the whole length of two great halls to the innermost sanctuary and fall upon the central figures of Amon-Ra and Ramses, ahich are there enthroned with Ptah of Memphis and Ra-Horakhti on either side. The interior of the temple consists of a series of halls, penetrating for 185 ft. into the solid rock and decorated with coloured sculpture of fine workmanship and in a good state of preservation; some of the scenes are of religious import (among them Ramses as king making offerings to himself as god). others illustrate mar in Syria, Libya and Nubia; another series depicts the events of the famous battle with the Hittites and their allies at Kadesh, in which Ramses saved the Egyptian camp and army by his personal valour. Not the least important feature of the temple belongs to a later age when some Greek, Carian and Phoenician soldiers of one of the kings named Psamtik (apparently I. 663–609 B.C.) inscribed their names upon the two southern colossi, doubtless the only ones then clear of sand. These graffiti are of the highest value for the early history of the alphabet. and as proof of the presence of Greek mercenaries in the Egyptian armies of the period. The upper part of the second colossus (from the south) has fallen; the third was repaired by Seti II not many years after the completion of the temple. A small temple, immediately to the south of the first, consists of a single rock-cut chamber originally preceded by an exterior antechamber. The scenes on the inner walls indicate that the temple served as a repository for divine barks that were carried in procession. The third and northernmost temple, separated from the others by a ravine, is on a large scale; the colossi of the façade are six in number and 33 ft. high, representing Ramses and his queen Ncfertari, to whom he dedicated the temple for the worship of the goddess Hathor.

Among the Nubian monuments that are in danger of being completely submerged by 1968 in the gigantic reservoir of water created by the erection of a high dam at Aswan, the Abu Simbel temples are the most important because they are architecturally unique. In 1955 an internationally composed team of Egyptologists began to record the scenes and inscriptions at Abu Simbel, and in 1960 UNESCO launched a world-wide appeal in an effort to obtain funds to preserve the major monuments in Nubia from complete inundation. In the case of Abu Simbel an oval-shaped cofferdam was planned to be erected around the two temples to hold back the waters. (E. F. W.)

ABU TAMMAM (Arab. ABU TAMMAM HABIB IBN AWS) (c. 800–c. 845), Arab poet, best known as the compiler of the anthology of early Arabic poems known as the *Hamasah* (*q.v.*). He was born about 800 either in Jasim (Josem) or near Manbij (Hierapolis), and he died in Mosul about 845. Two other similar collections are ascribed to him. His own poetry has been variously judged by Arab critics, some of whom regard him as the greatest of the poets of the Abbasid era.

For his collected poems see the critical edition by Muhammad 'Abduh 'Xzzam (1951–).

For his life see Ibn Khallikan's biographical dictionary, in Eng. trans. by M'G. de Slane, vol. i, pp. 338 ff. (1842); and *Kitab al-Aghani* ("Book of Songs") of Abulfaraj, vol. xv, pp. 100–108 (1905–06).

ABUTILON, a genus of more than 100 species of tropical shrubs or herbs (rarely trees) of the mallow family (Malvaceae), including such greenhouse favourites as the flowering maple (*Abutilon hybridum*), which is often used as a summer bedding plant. Abutilons have alternate leaves, often showy bell-shaped flowers and dry, beaked fruits. Some have beautifully variegated leaves and there are many horticultural forms. All should be grown in a cool greenhouse. in reasonably rich potting soil. They are easily propagated by cuttings of young twigs inserted in moist sand. Abutilon is found throughout the world. except on the European continent, and one weedy species (*Abutilon theophrasti*), the velvetleaf (*q.v.*), yields China jute, a bast fibre used for cordage. Besides the flowering maple, more than 15 ornamental species are cultivated in England, usually in the greenhouse; among them is *Abutilon esculentum,* the cooked flowers of which are eaten by Brazilians, under the name Bencao de Dios. (N. TR.)

ABUTMENT: see BUTTRESS.

ABYDOS, an ancient town of Mysia, the site of which lies just northeast of the modern Turkish town of Canakkale on the east side of the Dardanelles (Hellespont) at the narrowest point of the straits. Probably originally a Thracian town. it was colonized about 670 B C. by the Milesians. There Xerxes crossed the strait on his bridge of boats when he invaded Greece in 480 B C. Abydos is celebrated for its vigorous resistance to Philip V of Macedon (200 B.C.) and for the legend of Hero and Leander. It survived until late Byzantine times as the toll station of the Hellespont.

ABYDOS (Egyptian ABDU, Coptic EBOT), one of the most sacred cities of ancient Egypt. The site, now called al-'Arabat al-Madfuna, is in the low desert west of the Nile, near al-Balyana, about 100 mi. N. of Luxor. Abydos was the necropolis city for nearby Thinis, capital city of the eighth norne of upper Egypt.

The history of Abydos is intimately associated with the political and religious development of Egypt itself and goes back to the beginnings of Egyptian history (see EGYPT). There, in two low mounds composed of votive potsherds of all ages, close to the foot of the cliffs, E. Amélineau late in the 19th century discovered a series of pit tombs, proclaimed by their contents and by the steles with royal names found above them to have been those of kings of the first two dynasties of Egypt. The full excavation and description of these tombs by Sir Flinders Petrie gave much information about the earliest dynastic culture of Egypt, although they had been extensively plundered. Doubt has subsequently been raised as to whether these tombs were the actual burial places

of the pharaohs whose names they bore: in Saqqara, a series of mastaba tombs found by W. B. Emery contained objects bearing the same royal names, and the far greater size of these mastabas and the richness of their contents and decoration have led many scholars to suppose that these are the real resting places of the early kings and that the custom of constructing a sham burial, or cenotaph, at Abydos was practised as early as the archaic period. Some of the 2nd-dynasty pharaohs, however, may in fact have been buried at Abydos, and they built imposing brick fortresses at the northwestern end of the necropolis area; one, Shunet ez Zebib, covers nearly two acres.

The tutelary deity of the necropolis city was the jackal-god, in the Old Kingdom called Khenti-amentiu. By the 5th dynasty a new deity, the god Osiris, whose cult spread from Busiris (Djedu) in the delta, had become associated with Abydos. The city soon became the focal point of the cult of Osiris, which gradually absorbed that of Khenti-amentiu. Various places mentioned in the Osiris legend were located in and around Abydos, and one of the early tombs most revered by later generations, that of King Djer, was eventually selected as the authentic tomb in which the dismembered god's head mas thought to be buried. The city became known as Abdu ("hill of the reliquary"); Abydos is the Greek form. At least as early as the 12th dynasty a sacred drama or mystery play dealing with the death and resurrection of Osiris came to be enacted at Abydos.

Abydos became a place of pilgrimage for pious Egyptians, who desired above all else to be buried as close as possible to the tomb of Osiris. If burial in the sacred precinct was not attainable—and few could afford the expense involved—it was possible to set up a stone in the necropolis inscribed with the dead man's name and titles and a prayer to the god. Thousands of these steles have been found in the cemeteries. Over the mound where the early tombs were known to be, the mound of votive pots grew, and the site is now known to the Arabs as Umm el-Ga'ab ("mother of pots").

The pharaohs, though they were now buried near their residence city, encouraged the cult of the deified king at Abydos and took especial care to embellish and enlarge the temple of Osiris, erected on the site of an older temple of Khenti-amentiu. It was entirely rebuilt by Pepi I, of the 6th dynasty, and much enlarged by the pharaohs of the 12th. In the 18th dynasty Ahmose I built a chapel and Thutmose III a far larger temple (about 130 by 200 ft.). Thutmose also made a processional way from the temple to the cemetery, with a granite gateway. Ramses III added a large building and Ahmose II (Amasis) in the Saite period rebuilt the temple once more and placed in it a large monolithic shrine.

Some pharaohs had a cenotaph or a mortuary temple at Abydos. The temple of Seti (Sethos) I, first excavated by A. Mariette in 1859, is one of the most beautiful of all the temples of antiquity. Its plan is unique, for it has no fewer than seven sanctuaries, approached through two broad hypostyle halls. The sanctuaries are dedicated to the king and the principal gods of Egypt. Behind lie halls devoted to Osiris, Isis and Horus, and to the south, at right angles to the axis, are other halls dedicated to the god of the underworld, Sokaris, and to Nefertum. In a long gallery leading to these halls is a relief showing Seti and his son Ramses making offerings to the cartouches of 76 of their dead predecessors beginning with Menes. This is the so-called Abydos list of kings (see CHRONOLOGY: Egyptian). The reliefs decorating the walls of this temple are of particular delicacy and beauty. Nearby is a smaller temple, built by Ramses II.

Only 26 ft. behind the temple of Seti I is a remarkable structure known as the Osireion, but probably in reality Seti's cenotaph. This curious monument, completed by the pharaoh Merenptah, is an underground vaulted hall containing a central platform with ten monolithic pillars surrounded by a channel of water. Perhaps the whole was an allegory in stone, a cosmological symbol of the primeval hill amid the waters of the deep.

Around and between the temples is a vast complex of cemeteries of every period of ancient Egyptian history, from the prehistoric age to Ptolemaic and Roman times. Abydos is one of the most important archaeological sites in Egypt.

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ABYSS, any deep place (Gr. *a,* "not"; byssos, "bottom"), a bottomless depth. In general, the abyss is regarded vaguely as a place of indefinite extent, the abode of mystery and sorrow.

In the Greek version of the Old Testament the word represents the original chaos (Gen. i, 2) or the Hebrew tehom, which is used also in apocalyptic literature and in the New Testament for hell. In the Septuagint cosmography the word is applied to the waters under the earth, from which the springs and rivers are supplied, and to the waters of the firmament, which were regarded as closely connected with those below. Derivatively it acquired the meaning of the place of the dead. In Revelation it is the prison of evil spirits, from which they may occasionally be let loose, and where Satan is doomed to spend 1,000 years.

In rabbinical cosmography the abyss is a region of Gehenna situated below the ocean bed and divided into three or seven parts imposed one above the other. In the cabala the abyss as the opening into the lower world is the abode of evil spirits, and corresponds to the opening of the abyss to the world above.

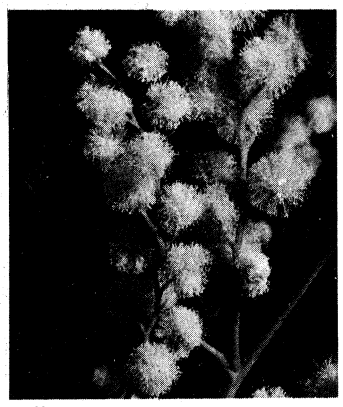
The adjective abyssal is used to describe deep regions of the sea. In heraldry the abyss is the middle of an escutcheon.

ABYSSINIA: see ETHIOPIA.

ACACIA, a large genus of trees and shrubs belonging to the pea family (Leguminosae); the genus comprises a group of several hundred species widely distributed over the warmer regions of the world, but particularly abundant in Australia and Africa. The leaves are usually twice compounded (bipinnate); in some instances, notably with Australian species native to arid localities, the leaflets are suppressed, their stalks (petioles) then becoming flattened and acquiring the physiological functions of leaves. These stalks are commonly vertically arranged, an orientation which precludes the inception of intense sunlight, thus apparently preventing injury through the retardation of excessive surface evaporation.

The small, frequently fragrant flowers are arranged in rounded or elongated clusters. The several seeded podlike fruits are either flattened or cylindrical, often with constrictions between the seeds. Sharp spines arm the branchlets of many forms.

True gum arabic is the product of Acacia *senegal,* a native of both east and west tropical Africa (see GUMS, PLANT). The Indian A. arabica yields a similar gum, but of inferior quality. Catechu (*q.v.*) or cutch is procured from A. catechu and several other species. Extractions from finely divided wood of this tree are employed in dyeing khaki cloth. The barks of most acacias are rich in tannin. Babul or babool, derived from A. arabica, is used in India for tanning. The Australian acacias, often called wattle barks, are important sources of tannin; especially valuable are golden wattle (A, pycnantha), green wattle (A. decurrens) and silver wattle (A. d. dealbata). The golden wattle is the Australian national tree and flower.



A. W. KERR

FLOWERING BRANCH OF SILVER WATTLE (ACACIA RECURRENS DEALBATA)

A few acacias are productive of valuable timber. Australian blackwood (A. melanoxylon) is a highly figured wood used in cabinetry. A. homalophylla, also Australian, yields a fragrant, decorative wood. Koa (A. koa), a native of the Hawaiian Islands, produces a handsomely figured wood used in the manufacture of

ukeleles. *A. heterophylla* from Mauritius and Bourbon is another excellent timber tree. The biblical shittah tree *(A. seyal)* is also a member of this group. Species noted for their heavily developed spines include the Australian kangaroo thorn *(A. armata)*, the giraffe acacia or African camel's-thorn *(A. giraffae)* and the Central American *A. sphaerocephala* and *A. spadicigera.* The large thornlike stipules of the two last-mentioned acacias are hollow and provide shelter for ants that feed on leafstalk secretions and curious food bodies at the tips of leaflets.

Sweet acacia *(A. farnesiana)* of the southwestern United States has been introduced into India and southern Europe. Its fragrant. yellow flowers are used in making perfume. The term acacia has been erroneously applied to species of the genus *Robinia,* also a member of the Leguminosae. The American black locust *(Robinia pseudoacacia)* is the false acacia so widely cultivated in milder parts of Great Britain. (E. S. HR.; X.)

ACADEMIC FREEDOM embraces freedom in teaching and freedom in learning, or *lehrfreiheit* and *lernfreiheit* in the language of Germany where the modern conception of academic freedom took form in the 19th century. It is that freedom of members of the academic community, assembled in universities and colleges, which underlies the effective performance of their functions. In modern understanding it embraces intellectual freedom, which is necessary to the acquisition and exchange of knonledge and to inquiry into the unknown, and freedom of creative activity in those arts which are practised in colleges and universities or in which training is offered: it includes also certain personal freedoms in relation to conduct outside of their institutions, which are deemed essential to faculty members and students as such. All of these freedoms exist elsewhere in society as well; but in higher education they occur in a specific institutional context which renders academic freedom distinctive.

Because of the social role of ideas, struggles over academic freedom between the academic community and other interests in society have taken place in all ages and in many circumstances. The nature and outcome of those struggles have been influenced by the forms of organization of academic institutions and the varieties of external authority over them. European universities began as self-constituted communities of scholars; but since these scholars were mainly ecclesiastics, the institutions they founded came under the sponsorship of the medieval church. Before the 18th century the Roman Catholic Church and in some areas its Protestant successors at times exerted a censorship with which the universities or members of their faculties found it necessary to contend. In the 18th and 19th centuries the political state became in many instances the supervising power. Aided by a tradition of faculty government within the institutions, relationships developed in most of the countries of western Europe which (with occasional lapses, notably in the Nazi period in Germany and in other dictatorships) eliminated external control over thought and teaching as an incident to the support and sponsorship of higher education. Faculty members were also left free of institutional control in their teaching and research. Students, similarly left largely free, were subject to the completion of examination and thesis requirements. In England, however, the relation of the established church to Oxford and Cambridge resulted in the maintenance of religious tests for university personnel of these institutions into the 19th century.

In the United States, in the absence of self-constituted communities of scholars, colleges and universities were established by religious or private nonsectarian groups and by states and, occasionally. cities for instruction and, later, for research and development of the arts and professions. Faculty members were hired. Representatives of the founders and their successors, established as boards of control, have remained vested with full legal authority over the institutions they head and have delegated much of it to academic administrators. The faculties usually lack legally secure authority to share in institutional government. Academic tradition and the professional status of faculty members have. nevertheless, served to establish a high degree of independence of the individual in teaching and research, and there has developed considerable faculty participation in college and university government. Students in the United States have been subjected to a rather paternalistic relationship which imposes significant curricular requirements and controls over conduct. Developments in the overseas countries of the British Commonwealth have been similar in various respects to those in both England and the United States.

The academic profession in the United States has formulated principles relating to academic freedom and to a correlative, academic tenure, which has grown up, for the purpose of clarifying academic freedom and of safeguarding it by protecting the faculty member against unwarranted loss of his position or dismissal without a hearing. Originally set forth by the American Association of University Professors in 1915, these principles were supported by other organizations as well and became incorporated into the bylaws of many universities and colleges. Because they are of varying legal effect, their observance rests largely on academic and public opinion, sometimes called into play by investigations of alleged violations and publication of reports upon them. Clearly stated religious limits to academic freedom when the aims of an institution require them are recognized as permissible, but are generally regarded as qualifications to freedom rather than as consistent with it.

Academic freedom in the United States has been strongly influenced by court interpretations of the constitutional freedoms of speech, press and assembly and is itself included to some extent in the protection these freedoms receive against governmental impairment. State requirement of military training of students in state institutions, exclusion of students and faculty from public institutions on account of race, the power of legislative investigators to inquire into educational affairs, and the validity of requiring political oaths of academic personnel have come under judicial scrutiny. The constitutional freedoms of faculty members outside their institutions, which may be vindicated in court, have also been brought within the protections accorded to academic freedom by professional action; for in a democratic society, in which scholarship often is directed consciously to the service of specific social interests, the scholar demands liberty of action in public affairs as a professional as well as a personal right.

Academic freedom on the part of faculty members is accompanied by recognized obligations: the obligation to preserve scholarly objectivity; to refrain from using the classroom for extraneous purposes; and to distinguish the individual's personal role from his institutional or academic capacity. Observance of these obligations is enjoined upon members of the academic profession in the United States by the nationally recognized principles of freedom and tenure.

See also CIVIL LIBERTIES; EDUCATION, HISTORY OF; EDUCATION, PHILOSOPHY OF; UNIVERSITIES.

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(R. F. Fu.)

ACADEMIES. The term "academy" is derived from the Greek *Academia,* originally an olive grove of a local hero, situated two miles from Athens. There Plato started his school, which became known by the same name *(see* ACADEMY, GREEK). Gradually the term acquired a general meaning of a higher school and in that sense it was used by Ptolemp I in Alexandria, by Spanish Muslim caliphs, by Charlemagne, by Alfred the Great and others. It is still used for some secondary schools and higher teaching in-

stitutions in many countries. The Calvinists in France, Switzerland and the Netherlands called their higher institutions "academies" until the 18th century, when the term "university" was generally adopted. In England both the dissenting and private institutions imparting secondary or higher learning were also called "academies," especially in the 18th century. In modern times many institutions for higher learning in special subjects such as naval, military, agricultural, fine arts, music or commerce have been called "academies." From the Renaissance the term was associated with learned societies which mere not schools in the ordinary sense. and in this use "academy" may be defined as a society or institution for the cultivation and promotion of literature, of arts and sciences or of some particular art or science.

The beginning of such societies can be traced to the 13th and 14th centuries. Thus Brunetto Latini started a speculative society (Accadernia) in Florence in 1270. The French troubadours started gatherings in Toulouse in 1323 for the promotion of poetry. In 1694 Louis XIV incorporated these gatherings as the Académie des Jeux Floraux. Most numerous and flourishing were these societies in Italy, where the movement started in 1439 in Florence subsequent to a Greco-Roman church congress. Two eminent Greek scholars, Gemistus Pletho and Johannes Bessarion, mere present, and, influenced by the former, Cosimo de' Medici founded in 1442 the Accademia Platonica in Florence for the study of Plato's philosophy and Greek literature. Bessarion went to Rome where he became a cardinal and the promoter of the Accademia Romana di Storia e di Archeologia, incorporated in 1498. Another early academy, the Accademia Pontaniana, was founded in Naples in 1442 under the patronage of Alfonso V of Aragon.

The first scientific academies belong to the 16th century. In 1560 Giambattista della Porta founded the Academia Secretorum Naturae, and in 1624, with G. B. Manso, the Accademia degli Oziosi, both in Naples. In 1575 Philip II of Spain founded in Madrid the Academia de Ciencias Matemiticas. The famous Accademia dei Lincei in Rome, to which Galileo belonged, was founded in 1603 by Federigo Cesi, but closed on his death. In 1870 it was resuscitated as the Reale Accademia Nazionale dei Lincei. In 1657 Leopold de' Medici founded in Florence the Accademia del Cimento, of which the physicist Torricelli was a member. (See also ITALY: Education: Academies.)

In Germany the first academy was Die Fruchtbringende Gesellschaft, founded at Weimar in 1617 for the purification of the language and the promotion of literature. The first German scientific academy was the Societas Ereunitica, founded at Rostock in 1622. In 1652 the physician J. L. Bausch founded at Schweinfurt an academy for research in medicine and connected sciences, called the Academia Naturae Curiosorum. It published in 1670 the first German scientific periodical, Miscellanea Curiosa. In 1687, in honour of the emperor Leopold I, it was renamed Academia Caesarea Leopoldina; later it became known as the Leopoldinisch-Karolinische Deutsche Akademie der Naturforscher, with its seat in Halle. It was also in the 17th century that the two pre-eminent scientific academies were founded. Both the English Royal society (*q.v.*) and the French Académie des Sciences began as informal gatherings of famous men. The "invisible college" of London and Oxford had its first meetings in 1645. It was incorporated as the Royal society in 1662. In Paris a group of men including Descartes, Pascal, P. Gassendi and M. Mersenne started private meetings almost at the same time. In 1666 they were invited by Colbert to meet in the royal library. In 1699 the society was transferred to the Louvre under the name of Académie des Sciences. The Académie Française also started as a private society of men of letters some five years before its incorporation in 1635 under the patronage of Richelieu. Another famous French academy, known as the Petite Académie, began as a committee of the Académie Française in 1663 for the study of ancient monuments, inscriptions and medals. In 1716 it became the Académie Royale des Inscriptions et Belles-Lettres.

In the 18th century the fame and achievements of the Royal society and of the Académie des Sciences were internationally recognized and many European countries started to found their own national academies of sciences. The chief promoter of this European movement was Leibniz. As early as 1676 he urged the establishment of an imperial academy of sciences at Vienna. He prompted Frederick I of Prussia to found in 1700 in Berlin the Societas Regia Scientiarum, renamed in 1711 the Preussische (later Deutsche) Akademie der Wissenschaften zu Berlin. In 1703 he presented a memorandum for the foundation of the academy of sciences at Dresden. During 1708–11 he wrote plans for a similar academy at St. Petersburg for Peter the Great. These and other plans were all realized and at the end of the period of enlightenment most European countries had their academies of sciences.

The academies of the 16th and 17th centuries were either scientific or literary. During the 18th century the rise of academies of the fine arts took place. As a rule they were societies closely connected with a higher teaching institution and thus differed from the earlier societies. The foundation of academies continued throughout the 19th century and in the 20th century national centres of sciences, literature and the fine arts were established in most of the new European and non-European countries.

Academies often have included by invitation distinguished foreigners among their members and so have helped to foster the international character of science and scholarship.

SCIENTIFIC ACADEMIES

Austria. — In 1786 I. von Born founded an international Society of Mining, but the Österreichische Akademie der Wissenschaften in Vienna originally planned by Leibniz was founded only in 1847 by the emperor Ferdinand I.

Belgium. — The Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique acquired its present title in 1845. It originated in 1769 as a literary society of which one of the founders was the English naturalist J. T. Needham.

Czechoslovakia. — The Prager Gelehrte Privatgesellschaft was founded by I. von Born in 1771. In 1784 it became Societas Regia Scientiarum Bohemica and in 1952 was refounded as the Czechoslovak Academy of Sciences (Ceskoslovenska Akademie Ved).

Denmark. — The Royal Danish Academy of Sciences and Letters (Det kongelige danske videnskabernes selskab) was founded at Copenhagen in 1742 by Christian VI.

France. — The old Académie des Sciences, together with all French academies, was suppressed in 1793 by decree of the Convention. In 1795 its functions were assumed by a branch of the newly formed Institut National. In 1816 the former name was restored to this branch, which became one of the five academies of the Institut de France.

Germany. — The Leibnizian academy was reconstituted in 1743 by Frederick II, who appointed the French scientist Maupertuis as president. The Bayerische Akademie der Wissenschaften in Munich was founded in 1759. Maximilian I entrusted it with the organization and supervision of public education. The Akademie der Wissenschaften at Gottingen was founded in 1751 by Albrecht von Haller. It was reorganized in 1897. The Akademie der Wissenschaften at Mannheim was founded in 1755 by the elector palatine. Scientific academies were founded at Leipzig in 1846 and at Mainz in 1949.

Hungary. — The Hungarian Academy of Sciences (Magyar Tudominyos Akadémia) was founded in 1825 by Count István Széchényi.

Italy. — Scientific societies existed in many towns, but the beginnings of a well-established and permanent academy of sciences belong to Turin. In 1757 G. B. Beccaria, J. L. Lagrange and others founded a private scientific society called Philosophico-Matematica Società Privata Taurinensis. In 1761 it became Società Reale and in 1783 Regia Accademia delle Scienze. The second in importance of Italian academies of the 18th century was the Accademia delle Scienze e Belle Lettere at Naples (1779), promoted by Tanucci. One of its prominent members was Gaetano Filangieri. The Accademia dei Ricovrati of Venice was also founded in 1779.

Netherlands. — The first scientific society, the Hollandsche Maatschappij der Wetenschappen, was founded in 1752. In 1774 a special section was added devoted to agriculture, industry and commefce. The Royal Institute of the Low Countries was founded

by King Louis Bonaparte at Amsterdam in 1808. It was reorganized in 1851 and in 1855 became the Koninklijke Nederlandse Akademie van Wetenschappen.

Norway. — J E. Gunnerus, the botanist, founded a scientific society at Trondheim in 1760. The Norske Videnskaps Akedemi at Oslo was founded in 1857.

Poland. — The first scientific society was founded in Warsaw in 1800 under the name of Towarzystwo Przyjaciol Nauk (Society of Friends of Science). The Cracow branch, opened in 1816, was reconstituted by the Austrian government in 1872 as an academy and in 1919 it nas renamed Polska Akademja Umiejetnosci. In 1951 it was transferred to Warsaw as Polska Akademia Nauk.

Portugal. — The Academia Real das Ciências was founded in 1779 by the duke of Lafões and Correa da Serra, both members of the Royal society. In 1851 it was reorganized into two sections of sciences and literature and social sciences.

Spain. — Although scientific societies were founded in 1575 and 1657, the academy of sciences dates back only to 1774. In 1847 it became the Real Academia de Ciencias Exactas, Fisicas y Naturales.

Sweden. — Archbishop Erik Benzelius, Emanuel Swedenborg and C. Polhem founded a private scientific society at Uppsala in 1710. In 1728 it received the title Kungliga Vetenskaps Societeten. Linnaeus mas one of the founders, in 1739, of a society in Stockholm incorporated in 1741 as Kungliga Svenska Vetenskapsakademien.

Switzerland. — Several cantons have their own scientific societies. The oldest is the Société pour l'Avancement des Arts in Geneva, started as a private society by H. B. de Saussure. It mas approved by the Geneva government in 1776. The Schweizerische Naturforschende Gesellschaft in Zurich, founded in 1815 on a national basis, has enjoyed the rank of an academy of sciences since 1931.

U.S.S.R.—The academy of sciences was founded by Peter the Great in St. Petersburg in 1724 and was opened by his widow, Catherine I, in 1725 as Rossiyskaya Akademia Nauk. The first Russian member was the scientist and poet M. V. Lomonosov. In 1934 the academy was transferred to Moscow. At Kiev the Academy of Sciences of the Ukranian S.S.R. was founded in 1918 and reorganized in 1919. The academies of other republics of the Soviet Union are of recent origin.

Yugoslavia. — Under Italian influence academies were flourishing in Dalmatia and Istria as early as the 16th century, for instance the Accademia dei Concordi at Dubrovnik. In Slovenia the Societas Unitorum at Ljubljana dates back to 1688. A society founded at Zagreb in 1848 by Bishop Strossmayer became in 1861 the Jugoslavenska Akademija Znanosti i Umjetnosti (Yugoslav Academy of Sciences and Arts). In Serbia the first society was founded in 1841. In 1864 it was named Srbsko Uceno Druzstvo (Serbian Learned society) and in 1886 it became the Srbska Akademija Nauka (Serbian Academy of Sciences) in Belgrade. The Slovenska Akademija Znanosti in Umetnosti (Slovene Academy of Sciences and Arts) was formed in 1937 from a society founded at Ljubljana in 1921.

English-speaking Countries. — The relations between state and society in the English-speaking countries differed from those in continental Europe. Culture, including religion, science, literature and the fine arts. was considered a prerogative of society and private initiative. Reflecting this attitude Great Britain, the commonwealth countries, Ireland and the United States have no state-established academies of sciences. They have, however, scientific societies which rival European academies in fame and importance.

Great *Britain.*—The oldest and best-known English scientific societies are the Royal society, the Gentlemen's Society of Spalding (1710). the Royal Society of Arts (1754). the Lunar society (1768) and the Royal Institution of Great Britain (1799). In Scotland the Royal Society of Edinburgh originated in 1739 as a philosophical society. In Ireland the Royal Dublin society was founded in 1731.

United States. — The most influential scientific society was founded by Benjamin Franklin in 1743. It was incorporated in 1780 under the name of American Philosophical Society Held at Philadelphia for Promoting Useful Knowledge and became recognized abroad as the national centre of scientific activities. In 1779 a group of Harvard graduates established a rival society in Boston, incorporated in 1780 as the American Academy of Arts and Sciences. The aims and organization were similar to those of Franklin's society and claims to represent the United States nationally were put forward. The New York lyceum, founded in 1817, was renamed the New York Academy of Science in 1876. The St. Louis Academy of Sciences was founded in 1856. The National Academy of Sciences was founded in 1863 in Washington, D.C. The Academy of Natural Sciences of Philadelphia was established in 1812. (See also ASTRONOMY, SOCIETIES OF; CHEMISTRY, SOCIETIES OF; HORTICULTURE AND BOTANY, SOCIETIES OF; ZOOLOGICAL SOCIETIES.)

LITERARY ACADEMIES

The Renaissance was not only the rebirth of classical literature and science, it also promoted national languages and literatures. Literary societies or academies were founded everywhere, but Italy was the source and model of this movement. In the 16th century the number of Italian academies approached 700. The most famous of Italian literary academies was the Accademia della Crusca, founded in Florence by A. F. Grazzini in 1582. Its Vocabolario *della* Crusca, published in Venice in 1612, stabilized the Italian literary language on the basis of Tuscan speech. In France the institution of this group is the Académie Française. The old academy of Richelieu was dissolved in 1793 and reconstituted as the third class of the Institut National in 1795. Napoleon, by abolishing the class of moral and political sciences, promoted it to the second class. In 1816 it was reconstituted under its old name. In Spain a similar role was played by the Real Academia Española, founded in Madrid by the duke of Escalona in 1713. The Russian Academy founded in 1783 became the eighth department of the Academy of Sciences of the U.S.S.R. The British Academy in London was founded in 1901. Its aim is defined in its charter as "the promotion of historical, philosophical and philological studies," or more precisely "the promotion of the study of the moral and political sciences, including history, philosophy, law, politics and economics, archaeology and philology." It will thus be seen that the British Academy combines literary and social studies.

In Latin America academies belonging to this group include the Academia Hispano-Colombiana de la Lengua founded in Bogotá, Colombia, in 1871, the Academia Chilena de la Lengua in Santiago, Chile, founded in 1885, and the Academia Venezolana de la Lengua. founded in Caracas, Venez., in 1882. (See also LITERARY, HISTORICAL AND ARCHAEOLOGICAL SOCIETIES.)

ACADEMIES OF SOCIAL SCIENCES

The two oldest academies of this group were founded in Portugal and Spain in the 18th century. They are the Academia Portuguesa da História (1720) and the Real Academia de la Historia (1738). The French Académie des Sciences Morales et Politiques can trace its origins to the Club de l'Entresol, known as the Académie Politique, which was influential until its closure by Cardinal Fleury in 1731. As the second division of the Institut National created in 1795 it was suppressed by Napoleon in 1803 as potentially subversive. In 1832 it was restored as one of the five academies of the Institut de France. The Academy of Social Sciences in Moscow, founded in 1956, is attached to the central committee of the Communist party. In the United States, the American Academy of Political and Social Science was founded in Philadelphia in 1889.

ACADEMIES OF FINE ARTS

The first academies of fine arts were in Italy. The Accademia di Belle Arti was founded at Perugia in 1546. It was followed by the Accademia di Disegno at Florence (1563), the Accademia di San Luca at Rome (1577) and the Accademia Albertina di Belle Arti at Turin (1652). The Akademie der Bildenden Kunste in Vienna was started as a school in 1692 but was not incorporated as an academy until 1770. The French Académie Royale de Peinture et de Sculpture had its beginnings in 1648. It was reconstituted

as the Académie des Beaux-Arts in 1795. In Denmark, Det Kongelige Akademi for de skønne Kunster (the Royal Academy of Fine Arts) was founded in Copenhagen in 1754. In the U.S.S.R., the academy founded in St. Petersburg in 1757 by Count Shuvalov was re-established as the Academy of Fine Arts of the U.S.S.R. in Moscow in 1921. The Royal Academy of Arts in London, founded in 1768, is described in a separate article. (See ACADEMY, ROYAL.)

In the Americas, the first academies of fine arts were the Academia das Belas Artes, founded in Rio de Janeiro, Braz., in 1816, and the National Academy of Design founded in New York in 1825, whose first president was S. F. B. Morse, later the inventor of the electric telegraph. (See also ART, SOCIETIES OF.)

MUSICAL ACADEMIES

Musical academies were started in Italy and grew from societies of musicians and poets in the 16th century. The Accademia della Fama in Venice was founded in 1558 by the musicians G. Zarlino, A. Gabrieli and others. The Accademia degli Arcadi in Rome, of which the composers A. Corelli, A. Scarlatti and B. Marcello were members, was founded in 1690. The Accademia Filarmonica of Bologna, founded in 1666, numbered Mozart among its members in the 18th century. In France, the Académie de Musique, also known as the Théâtre National de l'Opéra, originated in 1669. The Austrian Akademie für Musik und darstellende Kunst was founded in Vienna in 1817. The first musical academy in England was the Academy of Ancient Music, founded in London in 1710. A Royal Academy of Music, under the direction of Handel, existed in London from 1720 until 1728, but the present institution was founded in 1822 and incorporated in 1830. (See also MUSICAL SOCIETIES AND INSTITUTIONS.)

MEDICAL AND OTHER ACADEMIES

The Académie Royale de Chirurgie founded in Paris in 1731 was suppressed in 1793 and reopened in 1820 as the Académie de Médecine. Since 1871 it has been called the Académie Nationale de Médecine. The Russian Military-Medical Academy was founded in 1799. Other medical academies are of the 20th century.

The first mining academy, the Bergakademie at Freiberg in Saxony, eastern Germany, was founded in 1765. In 1914 a mining academy was founded in Cracow, Pol. The first agricultural academy was founded in Venice in 1790. The Royal Swedish Academy of Agriculture and Forestry (Kungliga Skogs- och Lantbruksakademien) was founded in Stockholm in 1811. The Timiryazev Academy of Agriculture and the V. I. Lenin All-Union Academy of Agricultural Sciences in Moscow, founded in 1865 and 1929 respectively, and the Bulgarian agricultural academy founded in Sofia in 1948, are higher educational institutions with the title of "academy." Commercial academies, all 20th-century foundations, exist in the U.S.S.R., Poland, Rumania and other countries. See also MEDICAL AND SURGICAL SOCIETIES; MILITARY, NAVAL AND AIR ACADEMIES. (N. H.)

ACADEMY, GREEK. The Greek school of philosophy known as the Academy took its name from Academia (Akademeia), a locality in the northwestern outskirts of Athens, where Plato acquired property c. 387 B.C. and used to teach; the designation, however, is most usually applied not to Plato's immediate circle but to his successors down to Cicero's time. Legally, the school was a corporate body organized for the worship of the muses, the scholarch (or head of it) being elected for life by a majority vote of the members. Most scholars infer, mainly from Plato's writings, that instruction in the Academy originally included mathematics, dialectics, natural science and preparation for statesmanship. The Academy continued in existence until A.D. 529, when the emperor Justinian closed it, together with the other pagan schools. The problem of its intellectual unity has always been controversial, particularly if its post-Ciceronian phase is included. Major differences concern its dogmatism and antidogmatism; its exclusiveness (syncretism); the primacy of speculation or of ethics; its religious ("mystical") or its secular ("rational") character. If these points are borne in mind, it seems reasonable to consider the Academy in five phases as follows:

1. The Old Academy (4th century B.C.), with Speusippus, Xenocrates, Polemo and Crates as successive scholarchs and with Philippus of Opus, Heracleides Ponticus (who had strong supranaturalist leanings), Eudoxus of Cnidus (outstanding as an astronomer) and Crantor as outstanding members, seems to have devoted itself mainly to the dissection of reality into spheres such as numbers, geometricals, soul, down to sensibles; or into spheres of knowledge, of opinion, of sensation. These appear to have been derived from one another or from a set or sets of ultimate principles, called "the one" and "the indeterminate dyad" or by analogous expressions. Discussion of the nature of "the one" and its relation to the good on the one hand and of the nature of the other principle and its relation to matter and evil on the other was combined with number-speculations in Pythagorean style, sometimes also with theology and demonology. In many respects the Old Academy was closer to what Aristotle presented as Plato's "system" than to Plato's works. Especially characteristic is the displacing of ideas in favour of numbers.

In what sense we should consider Aristotle a member of the Academy is a moot point.

2. The Middle (or New) Academy (3rd–2nd centuries B.C.) was the result of developments under Arcesilaus, when the school, with an obvious preference for Plato's early dialogues and in accordance with his criticism of sensation, turned antidogmatic — this tendency reaching its climax under Carneades about a century later (on the meantime we know almost nothing). Whereas Arcesilaus had mainly refuted all claims to infallibility put forward by the Stoics for certain sense-presentations, Carneades extended this refutation to all types of knowledge and criticized specific Stoic doctrines; *e.g.*, their teleology, theodicy, astrology and theology. The key word of this antidogmatism is epoche, the withholding of assent. On the other hand, Carneades developed a doctrine of degrees of probability (of particular importance in matters of conduct). In ethics he professed or at least defended the doctrine that the goal of life and happiness consists in the fruition of "natural" things such as the integrity of one's own body and mind, to secure which man is instinctively driven. The text and the canon of Plato's work were probably established by the Academy early in this period.

3. In the 1st century B.C. a neodogmatic turn started with Philo of Larissa and reached its climax with Antiochus of Ascalon. The latter asserted that Academics and Peripatetics originally were simply two branches of Platonism; and he traced Stoic doctrines (particularly their derivation of the standard of conduct from nature and their concept of *oikeiosis*, that is, the "propriety" of certain things to our nature and their "appropriation" as a foundation of morality) back to the Academy, with Polemo as key figure. This historical interpretation (the correctness of which is controversial) provided the justification for his syncretism. He accepted the division of philosophy into ethics, physics and logic (in order of decreasing importance) and distinguished goods of the mind and of the body and external goods, the last-named being essential for a life if it was to be not only happy, but consummately so (vita beata, beatissima). The reconstruction of additional doctrines of Antiochus (he has, for example, been credited with being the first to identify Plato's ideas with thoughts of God) and the tracing of their influence has been the object of much controversy.

Plato and Aristotle being excepted, not a single writing of any Academic mentioned hitherto has been preserved in its integrity. Some writings ascribed to Plato might, however, be Academic (on the *Epinomis*, see PLATO).

Cicero (*q.v.*), strongly influenced by Philo and Antiochus, combined a noncommittal attitude in matters of speculation with the conviction that, as the result of experiences (he says: innate ideas) common to all men, there is universal consensus in all matters relevant to conduct and religion.

4. Of the Academy after the time of Cicero we know little. In the 2nd century A.D., Calvisius Taurus was one of its scholarchs, and Atticus, a violent critic of Aristotle, perhaps another. With Eudorus, Albinus, Apuleius, Maximus of Tyre, Plutarch of Chaeronea, etc., they represent the so-called Middle Platonism, out of

which Neoplatonism developed.

5. In the 5th century A.D., when Platonism had already turned into Neoplatonism (since the 3rd century A.D.), the Academy becomes visible again. Within the Neoplatonic movement it constitutes the so-called Athenian school, distinct, for instance, from the Alexandrian in that it remained closer to the spirit of Plotinus (who had literary contacts with Eubulus, scholarch of the Academy), of Porphyry and of Iamblichus and was devoted to polytheism. Other scholarchs were Plutarch of Athens, Syrianus, Proclus and Damascius, the last of them; and Simplicius was a famous member. Neoplatonism professed to be genuine Platonism but assimilated many doctrines belonging to other schools and to Greek and oriental religions. It teaches an ineffable deity, absolutely transcendent and yet the source out of which, in a nontemporal process, everything "flows," "dispersing" and thus decreasing in reality but longing to return to its origin; this return in man taking place in "ecstasy," an act of nondiscursive knowledge.

See also PLATO; NEOPLATONISM; and articles on various Academic philosophers.

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ACADEMY, ROYAL. The foundation of the Royal Academy of Arts in London in 1768 was the outcome of a memorial to George III presented by a group of the leading painters, sculptors and architects then in Great Britain, seeking his interest in setting up "a Society for promoting the Arts of Design" of which the two principal objects were to be the establishment of "a well regulated School . . . and an Annual Exhibition." The king signed the instrument of foundation on Dec. 10 of that year and graciously declared himself therein to be the Academy's "patron, protector and supporter." It decreed that there should be 40 academicians and it named the first 34; it defined the society's activities, the functions of the council and general assembly, the offices to be filled and the manner of electing new members.

The main terms of the instrument have always been observed and form the basis of the laws in force today, the sovereign's approval being necessary for any amendment and for the appointment of the president and other officers. There are still 40 royal academicians who serve in rotation on the council and on the selection and hanging committees of the annual exhibitions. Two major changes have been made, in 1769 and in 1918. The former instituted a class of associates (not less than 30 and not more than 35 in number) who are represented on various committees and from whom the academicians are elected. The latter change inaugurated the terms "senior academicians" and "senior associates" for members reaching the age of 75. They are then no longer eligible to serve in any office or committee although they retain their vote in general assembly and other rights. The vacancies thus created in the active lists, together with those caused by death or other reasons, are filled by election among all members. New royal academicians are each required to present to the Academy a specimen of their art before receiving their diplomas signed by the sovereign.

From small temporary quarters in Pall Mall and old Somerset house, the Royal Academy moved in 1780 into the Strand block of the present Somerset house where it remained for 57 years. From 1837 to 1868 it was housed in the eastern half of the building on the north side of Trafalgar square (subsequently entirely occupied by the National gallery) and finally, on attaining its centenary, took possession of Burlington house in Piccadilly and built the main galleries and schools at its own expense on part of the gardens. The house itself was adapted for the library, offices and meeting rooms, and a third story was added to accommodate the diploma works.

The annual exhibition, by which the academy is perhaps best known to the public, has been held every summer without a break since 1769. Each member is allowed to send in not more than six paintings, drawings, engravings, pieces of sculpture or architectural designs, and any other person, of whatever nationality or domicile, may submit three. Over 10,000 items are received every year and an exhibition of some 1,500 is formed. No commission is deducted from the prices of the many works which are sold.

The winter exhibitions in the main galleries, usually of the works of old masters, were started in 1870 and have included large-scale displays of the highest international importance. Since 1952 the diploma galleries also have been used for special loan exhibitions from time to time throughout the year.

Entrance to the Royal Academy schools has always been "free to all students who shall be qualified to receive advantage from such studies." Successful candidates for the schools of painting and sculpture are admitted for a period of three months and thereafter, if approved, for a studentship of four years. The school of architecture was run on similar lines till 1947 when it was reconstituted as a postgraduate course of one year.

The Royal Academy has never received any subsidy from the state and except for the first 11 years of its existence, when the deficits were reimbursed from the king's privy purse, it has been financially self-supporting. The maintenance of its premises and the general administrative costs, together with the provision of free training in the schools, have all been paid for from the public's support of the exhibitions. In addition the Academy has been enabled, through the receipt of certain trust funds, to give scholarships and prizes to its students, to award annuities and grants to artists in distress, and to purchase works of art under terms designed to encourage artists living in Great Britain.

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ACADIAN, a descendant of the French settlers in Acadie or Acadia, the French colony on the Atlantic coast of North America in what is now eastern Canada. The area, visited by Champlain (1603) and by De Monts (1604) and colonized by the French, was long a bone of contention in the mars between France and England. By the treaty of Utrecht (1713) Acadia became English. In 1755 the imminence of war with France, the vexed question of the neutrality of the Acadians and the possibility of revolt led to their forcible deportation—the theme of Longfellow's ***Evangeline.*** They were distributed among the English colonies, and one group made its way to Bayou Teche, La., where George Washington Cable (*q.v.*) described their subsequent life. After the treaty of Paris (1763) left the British in undisputed possession of Canada, and Acadia had ceased to exist as a political unit, a number of Acadians found their way back to Nova Scotia and New Brunswick. In many cases their descendants continued to form a distinctive part of the population. See NOVA SCOTIA: ***History.***

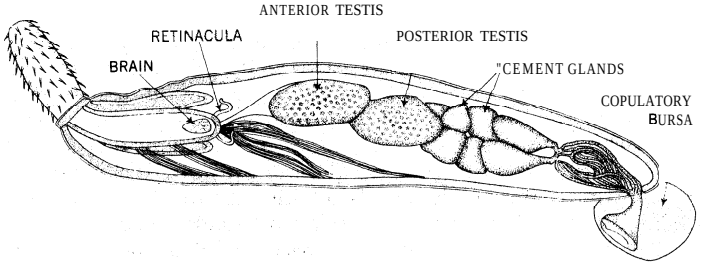
See G. P. Bible, *An Historical Sketch of the Acadians* (1892); A. Doughty, *The Canadian Exiles* (1914); Grace Dean McLeod, *Stories of the Land of Evangeline* (1891).

ACANTHACEAE, containing about 240 genera and more than 2,200 described species, is a largely tropical family of plants allied to the Gesneriaceae and Bignoniaceae. They are perennial herbs, armed or unarmed shrubs, or rarely trees or vines. A few

genera are cultivated as ornamentals. Chief among these, and probably the best known because of the use of the leaf pattern in the design on the Corinthian columns, is *Acanthus* (*q.v.*). Other genera grown in greenhouses or out of doors in warm climates are *Ruellia, Pseuderanthemum, Aphelandra, Thunbergia, Fittonia, Jacobinia* and *Justicia.* The family can be recognized botanically by the following combination of characters: the opposite, usually large and thin leaves. commonly provided on the surfaces with minute whitish lines (cystoliths); the absence of stipules; the usually compound inflorescences; the presence of persistent. often conspicuous, floral bracts; the irregular, tubular, two-lipped, often highly coloured (red, purple or yellow) corollas; the four (or sometimes two) stamens inserted on the corolla tube; the free two-celled ovary; and the often club-shaped capsule, opening elastically from the apex downward. (EY. C. L.)

ACANTHOCEPHALA, the spiny-headed worms, a phylum of parasites characterized by an anterior attachment organ (the proboscis) covered with rows of recurved hooks. These elongate worms as adults are found only in the intestine of vertebrates, and no free-living stage is present in any phase of their life histories. They vary in length from about $\frac{1}{16}$ in. to over 1 ft.

The Acanthocephala exhibit many of the aspects of "degeneracy" usually associated with parasitism. There is not the slightest trace of a digestive system in any stage of their development, and the relatively few sense organs, when they are present, are small and inconspicuous. The "brain" consists of a small cluster of cells located in an anterior muscular sac, the proboscis receptacle, into which the proboscis is retractable. Only a few species have any excretory system.



MALE ACANTHOCEPHALUS RANAE. A PARASITIC WORM THAT LIVES IN THE INTESTINES OF FROGS AND NEWTS

Natural History. — The spiny-headed worms undergo a two-host life history: the definitive host for the adult parasite is always. a vertebrate, most commonly a fish or bird, and the intermediate host is always an arthropod such as an insect or crustacean. (Sometimes a "transport host" is interpolated between the intermediate and definitive hosts. It is not clear how necessary such transport hosts are for the completion of the life history.)

The arthropod host ingests the infective embryo which then hatches into the first larval stage, the acanthor. After penetrating the gut, the acanthor enters the body cavity of the host, where it successively develops into an acanthella and finally into a later larval stage, the cystacanth. Vertebrates are infected by feeding on arthropods containing infective cystacanths. Upon ingestion the cystacanth begins development to the adult stage. After anchoring itself, by means of its burrlike proboscis, to the intestinal lining of the host, the worm absorbs nourishment directly through its thin body covering.

Because of their method of attachment, the spiny-headed worms are relatively destructive parasites. Heavy infections. frequently fatal, have been reported among fish, birds and monkeys. Lighter infections produce significant damage to the intestinal wall.

Structure and Function. — The acanthocephalan body is divided into two structural units: The presoma and the trunk. The presoma consists of the proboscis, neck, proboscis receptacle, brain and two internal fingerlike projections (lemnisci) in the neck region. The proboscis varies from globular to elongate-cylindrical in shape and is armed with a varying number of hooks, usually arranged in a definite pattern and relatively constant in size and number for each species. Inside the proboscis a pair of muscles, the invertors. connect the tip of the proboscis to the posterior portion of the receptacle. Contraction of these muscles causes the introversion of the proboscis into the receptacle. The neck region extends from the basal row of hooks to the beginhing of the trunk and is devoid of hooks and spines. It is usually quite short but in some forms, for example *Pomphorhynchus,* is remarkably elongated and specialized. The lemnisci are structurally and functionally connected to the subcuticula layer *(see* below) of the proboscis. Lemnisci are found in no other group of the animal kingdom and their function is unknown. Both the lemnisci and the proboscis receptacle project posteriorly into the trunk.

The trunk, the main part of the body, has a covering composed of a thin cuticula under nhich lies a thick, complex subcuticula. In many forms the cuticula is covered with spines nhich are primarily, if not entirely, limited to the anterior region of the trunk. The subcuticula is syncytial (lacking cell boundaries) and contains a rudimentary circulatory system, the lacunar system. The organs of the reproductive system are located in the trunk. In the male they consist of two testes, a variable number of cement glands and a muscular, copulatory bursa, within which is the penis. In the female, the ovary breaks up into "germ balls," where the eggs are produced, fertilized by the male's sperm and started on their development. After a period of maturation in the body cavity the embryonated eggs are passed into the anterior end of the female reproductive system, the uterine bell. From there a selective apparatus either passes the embryos on through the female ducts and out the genital pore or returns them to the body cavity for further development.

Classification. — There are approximately 400 species in about 85 genera. These are divided among at least three major groups.

1. The Archiacanthocephala are primarily parasites of terrestrial hosts. Examples include: *Macracanthorhynchus,* infecting beetle grubs and hogs; *Moniliformis* of roaches and rats; and *Mediorhynchus* of grasshoppers and birds.

2. The Palaeacanthocephala are parasites of aquatic and marine hosts. Examples include: *Polymorphus* of amphipods and ducks; *Eclzinorhynchus* of amphipods and fish; and *Corynosoma* of amphipods and ducks or seals, with fish serving to transport the parasite from amphipod to seal.

3. The Eoacanthocephala are primitive forms found almost entirely in fishes. Examples are: *Neoechinorhynchus* and *Octospinifer* of ostracods and marine or fresh-water fish.

Superficially, the Acanthocephala bear certain resemblances to the nematodes, and more basic characters suggest similarities with the flatworms. However, nearly all authorities agree in recognizing Acanthocephala as a separate phylum.

See also PARASITIC DISEASES: *Acanthocephala.*

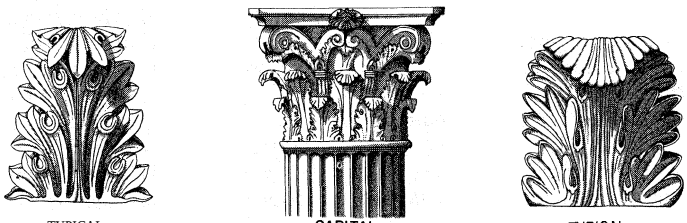
See L. H. Hyman, *The Invertebrates,* vol. **3,** *Acanthocephala, Aschelminthes, and Entoprocta (1951).* (W. L. BU.)

ACANTHODIAN, a small armour-plated fish, among the oldest jawed vertebrates, of the extinct group Acanthodii, often misleadingly called "spiny sharks." *See* PLACODERM.

ACANTHUS, a genus of plants of the acanthus family (Acanthaceae [*q.v.*]), embracing about 20 species, mainly perennial herbs and small shrubs, native to the Mediterranean region and the warmer parts of Asia and Africa. They are bold, vigorous, handsome plants, with mostly broad, much divided, often spiny-toothed leaves. The erect stems bear stately spikes of showy white, purple or red flowers, surrounded by sharp-pointed, sometimes highly coloured bracts.

Several species are grown as ornamentals. These are mostly thistlelike plants, with stems three feet to four feet high. The best known is the bears' breech or brankursine *(A. mollis),* common in Mediterranean countries, with deeply cut, hairy, shining leaves, which are without spines, and whitish or rose-coloured flowers in spikes $1\frac{1}{2}$ ft. long.

The spiny acanthus *(A. spinosus),* native to southern Europe, is so named because of its very spiny leaves. *A. perringi,* a native of Asiatic Turkey, with red flowers, is suitable for rock gardens. *A. montanus,* native to Greece, with roseate flowers, is grown in greenhouses.



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ARCHITECTURAL USES OF THE ACANTHUS DESIGN

In architectural decoration the acanthus was first reproduced in metal and subsequently carved in stone by the Greeks. It was afterward, with various changes, adopted in all succeeding styles of architecture as a basis for ornamental decoration.

There are two types: that found in the *Acanthus* spinosus, which seems to have been followed by the Greeks; and that in the Acanthus *mollis,* which seems to have been preferred by the Romans.

ACAPULCO, a resort city and port of Mexico, at sea level on the Pacific coast in the state of Guerrero, 288 mi. by road S.S.W. of Mexico City. Pop. (1950) 28,512; (1958 est.) 35,000, plus many transients. Acapulco has the best harbour on the Pacific coast of Mexico and one of the finest natural anchorages in the world; it is situated on a deep, semicircular bay, nearly landlocked and accessible by land. Acapulco was a main depot for Spanish colonial fleets plying between Mexico, the Philippines and the orient, and continued to be a port of call for steamship lines between Panamá and San Francisco as well as coastwise trading vessels. The town lies on a narrow strip of land between the bay and steeply rising mountains which encircle it. From May to November the climate is hot and humid, but from December through April it is warm and pleasant; February, March and April are almost rainless. Long a regional economic centre, Acapulco exports hides, cedar and fruit, as well as cotton. tobacco. cacao, sugar cane, Indian corn and coffee grown in the adjacent district of Tabares. No railways connect to Acapulco but a spreading network of highways and frequent air service make it accessible to visitors. Acapulco became "The Riviera of Mexico."

Many luxurious hotels attract tourists, and its principal beaches, Caleta and Los Hornos, offer excellent bathing facilities. Its deep-sea fishing is famous. A traditional tourist attraction is a spectacular dive into the sea from a high cliff by young men for whose benefit a collection is taken up by the spectators.

A main highway, passing through Taxco and Cuernavaca. runs to Mexico City, (R. B. McCk.)

ACARAI, SERRA (AKARAI MOUNTAINS). a range of low mountains on the border between Brazil and British Guiana, forming the watershed between the Rio Trombetas, which joins the Amazon just upstream from Óbidos, and the Oronoque river, which joins the Courantyne river on the border between British Guiana and Surinam. The underlying rocks are crystalline. On either side of the Serra Acarai there is a gently rolling crystalline hilly upland. At the headwaters, however, there is an erosion remnant, preserving a surface, developed during an earlier erosion cycle, that stands at an elevation of about 1,600 ft. above sea level with steep sides and a flattish top. The whole area is covered with a dense tropical rain forest and is little ex-lored. The range extends for about 80 mi. east and nest on the southeasternmost part of the British Guiana border. To the east, the same surface feature runs along the border between Brazil and Surinam. where it is called the Tumuc-Humac mountains. The Serra Acarai was formerly spelled Acarahy; in British Guiana the range is known as the Akarai mountains. (P. E. J.)

ACARINA (ACARI) the scientific name for the order of small arthropods comprising the mites and ticks. Many are parasites and become important for health and economic reasons when they attack man and animals and cause dermatitis or transmit diseases. See MITE; TICKS.

ACARNANIA (AKARNANIA), a district of ancient Greece, bounded by the Ionian sea, the Ambracian gulf, Mt. Thyamus (Petalas) and the Achelous river; its most populous region was the fertile plain of the lower Achelous. The inhabitants emerged late from barbarism (Thucydides noted that in the 5th century B.C. they still carried arms in everyday life), but in the 7th century Corinthian colonists had already settled the coastal areas. The Athenians later helped the Acarnanians to repel attacks by these colonists (perhaps in 437 B.C.) and by the Spartans (429–426); but in 390 they were overcome by Agesilaus and fell successively under the sway of Sparta, Athens and Thebes. They joined the resistance against Philip II of Macedonia but after the battle of Chaeronea (338 B.C.) submitted to Macedonian control. In 314 they established a confederation of newly founded cities; but frontier disputes with Aetolia culminated in the partition of their country between Aetolia and Epirus (c. 243). The Epirote part of Acarnania recovered its independence after 230 and was closely allied with Philip V of Macedonia in his Roman wars. In 167 it lost its new federal capital of Leucas and was forced to send hostages to Rome; but the confederacy with its capital at Thyrrheum survived until the time of the Roman principate, when Augustus incorporated many Acarnanians into his new city Nicopolis Actia, and the rest were included in the province of Achaea. Acarnania took a prominent part in the Greek national uprising of 1821. In modern Greece it is linked with Aetolia in the prefecture (nomos) Aitolia kai Akarnania, with its administrative centre at Missolonghi.

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(F. W. WA.)

ACASTUS, in Greek mythology, son of Pelias and brother of Alcestis, but the friend of Jason; he took part in the Calydonian boar hunt and the Argonautic expedition. After his father had been murdered by Medea (who persuaded his daughters that if he were cut up and boiled he could be revived with renewed youth) he instituted splendid funeral games in honour of Pelias, having succeeded to the throne of Iolcus. His wife Astydameia (so named according to Apollodorus. but called Hippolyte in Horace's Odes and in Pindar) fell in love with Peleus (*q.v.*), who had taken refuge at Iolcus, and accused him falsely to her husband (see BELLEROPHON; HIPPOLYTUS). Acastus thereupon left Peleus asleep on Mt. Pelion, having first hidden his famous sword. On awaking, Peleus was attacked by the Centaurs but saved by Cheiron. Having recovered his sword he returned to Iolcus and slew Acastus and Astydameia. (T. V. B.)

ACCADIAN LANGUAGE: see AKKADIAN LANGUAGE.

ACCA LARENTIA (LARENTINA), a Roman goddess whose festival, the Larentalia, fell on Dec. 23. Her original functions and the nature of her cult remain obscure because her legend was humanized and rationalized by writers such as Livy. Ovid and Plutarch, the main literary sources. One tradition described her as a prostitute who, in the early regal period, was won by Hercules at dice, married a wealthy Etruscan, Tarutius. and bequeathed her husband's property to the Roman people. In another account she was the wife of Faustulus. the herdsman who rescued Romulus and Remus (see ROMULUS), and the original *fratres Arvales* were her sons (see ARVAL BROTHERS). Sometimes, as Romulus' foster mother. she was equated with the she-wolf (*lupa* can mean "prostitute"). Modern scholars suggest that she was mother of the Lares (*q.v.*) and symbolized the earth's fertility, but the evidence is inconclusive.

See T. Mommsen, "Die echte und die falsche Acca Larentia" in *Römische Forschungen,* vol. ii (1879).

(D. E. W. W.)

ACCELERATION, as used in mechanics, denotes the rate of change. with time, in the velocity of a moving object or of some purely geometrical concept; *i.e.,* a point. Since velocity itself is by definition the time (t) rate of change of the distance (s) traversed by a moving object ($v = s/t$), this quotient is constant for uniform motion, or represents the average velocity during the interval t for nonuniform motion; measured in centimetres per

second (cm. sec.$^{-1}$). Likewise acceleration ($a = v/t$) is constant for uniform acceleration, or represents the average during the interval t for variable acceleration. This is measured as a rate of change of velocity (cm. sec.$^{-1}$) per second; *i.e.*, cm. sec.$^{-2}$ The term velocity is of a vector character, involving both magnitude (speed) and direction. A velocity may change in either or in both characteristics. Therefore, the idea of acceleration possesses vector characteristics. Near the surface of the earth and in *vacuo*, falling objects show slightly variable accelerations, depending on their location. The direction is approximately toward the centre of the earth and their rate of increase of speed is approximately 980.5 cm., or 32.2 ft. per second every second. See also MECHANICS.

See Index references under "Acceleration" in the Index volume.

(H. B. LM.)

ACCELERATORS, PARTICLE. In 1919 Sir Ernest Rutherford observed the disintegration of atomic nuclei under the impact of alpha particles emitted from a naturally occurring radioactive substance; this may be considered the beginning of nuclear physics as an experimental (rather than an observational) science. It was immediately apparent that a wider range of experiments could be performed if stronger and more flexible sources of fast nuclear particles could be made, and a great deal of effort during the next few years led to the development of several mays for producing such sources. In 1932 J. D. Cockcroft and E. T S. Walton first observed the disintegration of a nucleus by artificially accelerated particles. Thereafter, the importance of particle accelerators in nuclear research became comparable to that of telescopes in astronomy or microscopes in bacteriology. The particles accelerated are usually the nuclei of light atoms. such as the proton or deuteron from light or heavy hydrogen, respectively, or the alpha particle from helium; heavier nuclei may also be used, or electrons, which are lighter than any nucleus. Since each kind of particle produces its own characteristic effects on nuclei, research with all kinds is desirable. In the simplest general type of accelerator the particle, which bears an electric charge, is pulled along by a steady electric field, just as a falling rock is accelerated by the force of gravity. The particle acquires a kinetic energy equal to its charge multiplied by the difference in electric potential through which it falls. This concept leads to a unit of energy, the electron volt (ev), based on the electronic charge and the volt as a unit of potential; the abbreviation Mev (million electron volts) represents 1,000,000 of these units. An accelerator of this type would comprise an ion source, in which the charged particles are produced (for example, protons from hydrogen gas by the action of an electric arc); an evacuated tube, in which they can travel freely while acted on by the electric field; and some means for providing the required electrical potential. Of greatest importance are machines using potential sources of the kinds first used in this connection by Cockcroft and Walton and by R. J. Van de Graaff; these are suitable for energies up to about 1 Mev and 8 Mev, respectively.

Resonance Accelerators. — The practical limitation on particle energies obtainable in the above way is imposed by the difficulty of preventing electrical breakdown at high voltages. This difficulty can be avoided if the particle is accelerated in steps by the repeated application of a relatively small voltage, as in the general category of machines that can be called resonance accelerators. (The induction accelerator, representing another way around the difficulty, is discussed below under Betatrons.) The first resonance accelerator, built by R. Wideröe in 1927, is illustrated in fig. 1. This device served to introduce the idea to a scientific world that was eagerly searching for ways of producing high-energy particles. It led in two directions. One was the simple extension to more and successive stages of acceleration, giving rise to the family of linear accelerators. The other was a basic modification, the cyclotron, proposed by E. O. Lawrence of the University of California. Berkeley.

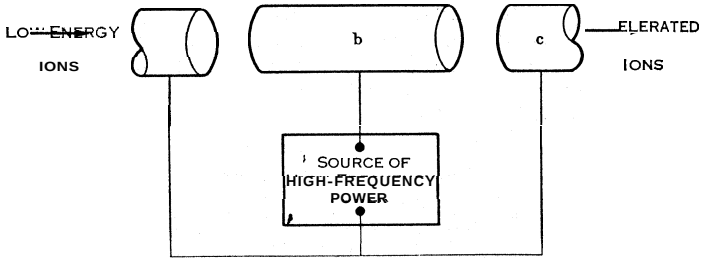


FIG. 1. — SCHEMATIC DIAGRAM OF SIMPLEST RESONANCE ACCELERATOR

Hollow cylinder b has an alternating potential with respect to a and c. If a positive ion enters the gap ab at a time when b is negative, it is attracted to b and thereby accelerated. The frequency of alternation is chosen so that when the particle reaches the gap bc the polarity has reversed and the particle, now being repelled by b, is accelerated again

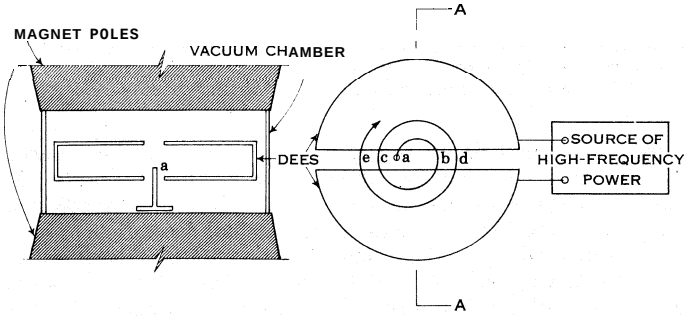


FIG. 2. — ELEMENTS OF A CYCLOTRON SHOWING (RIGHT) PLAN VIEW AND (LEFT) SECTIONAL VIEW AA

Ions from the source a are attracted by one of the hollow electrodes, called "dees" because of their shape. The magnetic field forces them to follow a circular path. When they reach the point b, the polarity of the electric field between the dees has reversed, and they are now repelled by the same dee that formerly attracted them. If the frequency of alternation is properly chosen, acceleration occurs also at points c, d, e, etc. The increasing energy causes the circular orbit to expand, resulting in a spiral path. When the ions reach the outer edge of the dees, they emerge through a channel not shown

In the cyclotron the particles are forced to move in a circular path by the action of a magnetic field. A particle of charge e (in absolute electromagnetic units) moving with velocity v (in centimetres per second) in a magnetic field of strength B (in gauss) is known to suffer a transverse force equal to Bev (in dynes). If the radius of the circular orbit is r, the centripetal acceleration is v^2/r and the radial force needed to keep the particle in the orbit is mv^2/r, where m is the mass in grams. Setting this equal to the magnetic force Bev and solving for r, we get

$$r = \frac{mv}{eB}$$

The important thing to notice about (1) is that, since the size of the orbit is proportional to the velocity, the time per rotation is a constant. The frequency f (number of times per second around the orbit) is simply the velocity divided by the circumference, or

$$2\pi f = \frac{eB}{m} \qquad (2)$$

For a deuteron in a field of 13,000 gauss, f turns out to be 10,000,000 cycles per second; these values of field and frequency are easily attainable. Fig. 2 shows how the periodic electric impulses are applied to the particles as they travel around their orbit between the poles of a magnet. In the hands of Lawrence and others, the cyclotron quickly developed into a very powerful tool for nuclear research. For example, the 60-in. cyclotron completed at Berkeley in 1939 can deliver a current of more than 50 microamperes (μ amp.) of 20-Mev deuterons.

There is, however, a practical limit to the energy obtainable from a cyclotron, first pointed out by H. A. Bethe and M. E. Rose in 1937. According to the principle of relativity, the mass of a particle increases as its energy increases; in equation (2) the mass m varies as:

$$m = m_0 + \frac{W}{c^2} \qquad (3)$$

where W is the kinetic energy in ergs, c is the velocity of light in centimetres per second and m_0 is the rest mass of the particle.

To illustrate the magnitudes involved, the mass of a proton is doubled when its kinetic energy is 938 Mev; for an electron the corresponding figure is 0.51 Mev. Thus relativistic effects become important for electrons at much lower energies than for protons and other heavier ions The effect on cyclotron operation is obvious: as the energy increases, the frequency of rotation decreases and the particle falls out of step with the applied high-frequency accelerating potential. Another fact to be noted is that, in a practical cyclotron, the magnetic field B must be weaker at the edge bf the pole than in the centre, since this sort of field distribution serves to keep the orbits in their proper position, as explained in the section headed *Cyclotrons and Synchrocyclotrons*. Therefore one cannot compensate for the mass increase by using a field in which B increases with the radius.

Synchrotron and Related Machines.—A practical nay for removing the relativistic limit from machines operating on the cyclotron principle was pointed out by V. I. Veksler in the U S.S.R. and, independently, by E. M. McMillan in the United States in 1945. This is based primarily on the recognition of a property inherent in cyclotron operation, which has been called phase stability. Fig 3 illustrates how this property comes about. The curve shows how the potential difference across an accelerating gap varies with time; and t_1 and t_3 are two successive times at which a particle is supposed to cross the gap, the energy gain at these times being such as to keep the particle at the required rate of acceleration. If the particle has less energy than it should have, according to equations (2) and (3), it will complete the orbit sooner than it should, and the second crossing of the gap will occur at a time such as t_2. The particle will therefore gain energy at an increased rate, tending to restore the initial deficit in energy. Similarly, an excess in rate is corrected by a motion of the time toward t_4. A more detailed analysis shows that the energy tends to oscillate about the correct value; the stability breaks down if a rate of energy gain greater than the peak of the curve is required. The stability in phase causes the motion of the ions to "lock in" to the applied radio frequency; or, in other words, the particles tend to seek out a state of motion in which equation (2) is satisfied, with f equal to the applied frequency. Thus a given set of

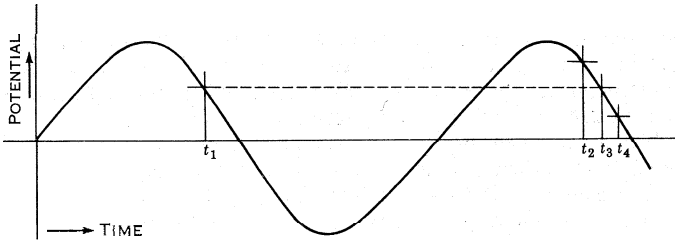


FIG 3.— THE PRINCIPLE OF PHASE STABILITY

values of f and B determine a value of m and therefore, by (3), of the energy W.

Acceleration is achieved if f or B (or both) is made to vary slowly in time during the flight of the particle. At the start, f and B have values corresponding to the initial energy of the particles; a decrease in f or an increase in B will lead to an increase in particle energy. Machines in which B is constant in tiine belong to the general category of cyclotrons; if the frequency is modulated they are called synchrocyclotrons or simply FM cyclotrons. The general term synchrotron is now applied to machines in which B varies with time. This is technically more difficult than variation of f, and is done only when the mass varies by a large factor, as in the acceleration of electrons, or of protons to extremely high energies. Some practical realizations of these possibilities are described in later sections. See also ATOM; ELECTRICITY; ELECTRON; MAGNETISM; NUCLEUS; PARTICLES, ELEMENTARY : RADIOACTIVITY. ARTIFICIAL. (E. M. Mc.)

VAN DE GRAAFF ACCELERATORS AND COCKCROFT-WALTON GENERATORS

Van de Graaff Accelerator.— This is an accelerator in which power at high voltage is supplied by means of an insulating belt which carries charge from ground to the high-voltage terminal.

As pointed out by Van de Graaff in an early publication, a high-voltage machine utilizing a charge-carrying belt was first proposed by Lord Kelvin. Van de Graaff, while a Rhoaes scholar at Oxford university, recognized the need for a steady, high voltage for particle acceleration and saw the possibilities of this device. After his return to Princeton university, Princeton, N.J., he built the first successful model in 1929.

In this device an electrical charge is deposited on a belt of insulating fabric. The charge is carried into a smooth, well-rounded metal shell. Here it is removed from the belt; it passes to the metal shell, and the shell will increase in potential until electrical breakdown occurs or until the charging current is balanced by load current.

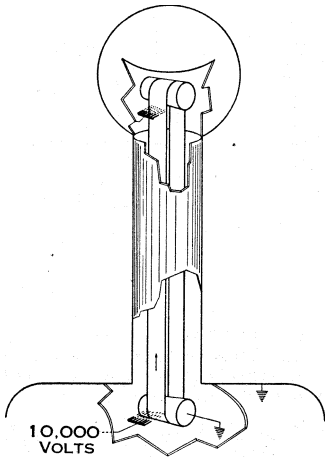


FIG. 4.— SCHEMATIC DRAWING OF A VAN DE GRAAFF ACCELERATOR

To charge the belt a corona discharge is maintained between a series of points or a fine wire on one side of the belt and a well-rounded electrode or inductor plate on the other side. Ionization takes place only near the sharp ends of the charging needles. If the needles are at a positive potential with respect to the inductor plate, positive ions move toward the inductor plate, which in many cases is a grounded metal pulley carrying the belt. The belt intercepts many of the ions and carries them into the metal shell, which serves as a high-voltage electrode. Here the charge is removed by an array of needle points electrically connected to the high-voltage electrode. The machine can be made to provide negative current to the high-voltage electrode by operating the charging needles at a negative voltage with respect to the inductor plate. Belt-charging electrodes must be electrically shielded from the field of the high-voltage terminal, and charge must be carried well within the high-voltage terminal before removal is attempted. Charging current is then independent of the potential of the high-voltage terminal. Terminal voltage will rise until it is limited by corona discharge, by leakage current along insulators, by spark-over or by some load such as ion current through an accelerating tube.

A working model which Van de Graaff built at Princeton consisted of a metal sphere 2 ft. in diameter supported by two Pyrex rods and charged by a silk belt 2.2 in. wide. Early machines followed closely the pattern of Van de Graaff's first model. Charging currents of several milliamperes were achieved, and voltages were commonly limited by spark-over through air from the high-voltage terminal. A smooth terminal approximately spherical in shape, with a radius of 1 m., was found to hold 1,000,000 v. satisfactorily; and from tests nith a number of machines the maximum voltage appears to be approximately a linear function of the radius of the terminal.

Work at Princeton and at the University of Wisconsin, Madison, showed that the machine could be made much more compact by enclosing it in a pressure tank and utilizing the high dielectric strength of high-pressure gases. A series of developments at Wisconsin resulted in 1940 in a compact machine operating up to 4,500,000 v. From later development work at the Massachusetts Institute of Technology, Cambridge, a machine was completed in 1950 operating up to nearly 8,000,000 v. Nearly all machines of this type use high-pressure gases for insulation.

These machines came into wide use in nuclear physics laboratories throughout the world. They are specially suited for experiments requiring moderate currents of ions with accurately defined energies. Van de Graaff machines operating up to 6,000,000 v. became commercially available in the 1950s.

Cockcroft-Walton Generator.—This is a particle accelerator

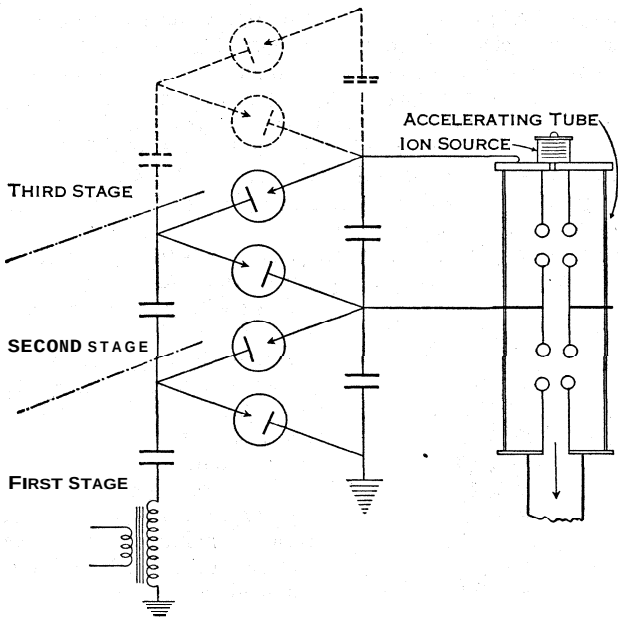


FIG. 5.— SCHEMATIC DRAWING OF A COCKCROFT-WALTON GENERATOR
The original machine consisted of two stages; dotted lines show the circuit arrangement for a third stage. After 1950 selenium rectifiers were developed for use in place of the electronic diodes previously used for rectification

in which a voltage multiplier is used to develop power at high voltage. The accelerator developed by Cockcroft and Walton for their transmutation experiments filled a need so successfully and proved so versatile that it was very widely copied.

In describing their early work, preceding completion of their successful machine, Cockcroft and Walton pointed out the advantages of a steady voltage for acceleration of charged particles. The stream of particles is then uninterrupted; and if fluctuation in voltage is held to a low value the variation of particle energy is small, and accurate measurement of transmutation phenomena is facilitated. Million-volt machines had been developed for the study of high-voltage insulators and for X-ray work, but they did not give the steady voltage desired.

For their high-voltage supply Cockcroft and Walton chose a circuit, commonly called a voltage multiplier, originated by H. Greinacher in 1920. This circuit consists of two stacks of series-connected condensers. One stack is fixed in voltage, except for ripple, with one terminal connected to ground and its other terminal connected to the load. One terminal of the second condenser stack is connected to a transformer; and if the peak voltage of this transformer is V, the voltages at all points along this condenser stack rise and fall within an amplitude of approximately $2V$. Series-connected rectifiers link the two stacks as shown in fig. 5. As the voltage on the oscillating stack rises and falls, charge is transferred stepwise from ground to the high-voltage terminal. Here the voltage is steady except for ripple caused by power drain and stray capacitance. and for no load it has a value of 2VN where N is the number of multiplier stages used.

Although extremely high voltages mould appear to be attainable by use of many stages, certain practical difficulties set an upper limit to the voltage. One of the most severe limitations is imposed by electrical breakdown through air between neighbouring parts. A 1,000,000-v. machine must be housed in a large room. Exposed terminals must be well grounded, and components must be grouped to minimize electrical gradients. The practical upper voltage limit for these machines when operating in air at atmospheric pressure appears to be about 1,500,000 v.

The high-voltage supply serves to furnish power to an accelerating tube which is equipped with an ion source at its upper terminal. Many of the early machines were limited in voltage by electrical breakdown in the accelerating tube. Multisection tubes of large physical extent have been required to avoid this difficulty. Condensers and rectifiers were a major pr'oblem in early machines, and Cockcroft and Walton had to build these components for their first machine. Later they became commercially available.

These machines are capable of relatively intense ion beams. The high-voltage supplies are usually capable of delivering many milliamperes of current, and ion sources yielding several milliamperes of ion current have been developed. Cockcroft-Walton machines are more numerous than any other type of particle accelerator. Many are designed for operation at only 100 or 200 kv. These are relatively compact and inexpensive and are used to provide neutron sources. Usually to provide neutrons, deuterons accelerated by the machine are directed onto a target containing deuterium or tritium. These reactions give prolific yields of high-energy neutrons at accelerating voltages even below 100 kv.

Low-voltage Cockcroft-Walton machines designed to serve as neutron sources are also commercially available. The N. V. Philips Gloeilampenfabrieken, Eindhoven, Neth., built a number of machines for 1,000,000 v. or more for general research work in nuclear physics. The company also produced machines of this type housed in pressure tanks. By taking advantage of the good insulating properties of high-pressure gases it developed a compact model operating up to 2,000,000 v. (R. G. HB.)

CYCLOTRONS AND SYNCHROCYCLOTRONS

The cyclotron is a major instrument for nuclear research. It is a device for accelerating protons and deuterons, as well as other heavier ions, to energies high enough to produce nuclear transformations in even the heaviest nuclei. The first machine to accelerate particles to high energies without the use of high voltages, it mas for many years the only accelerator able to produce heavy particles with energies above 5 Mev. Among the various accelerators which were developed to produce high-energy particles, the cyclotron proved to be the most useful and the most popular.

The synchrocyclotron is a modification of the cyclotron that makes practical the acceleration of ions to energies about 20 times greater than otherwise: energies great enough to make possible the production of new particles of intermediate mass, called mesons. The creation of mesons by the synchrocyclotron is a striking example of the conversion of energy into matter.

Cyclotron.—The first cyclotron, constructed by E. O. Lawrence and M. S. Livingston in the early 1930s, had a magnet of only $2\frac{1}{2}$-in. pole diameter and accelerated protons to 80,000 ev. This was followed at the University of California by the 9-, 11-, $27\frac{1}{2}$-, 37- and 60-in. cyclotrons and finally by the 181-in. machine. The construction of cyclotrons was taken up all over the world, wherever nuclear research was being actively pursued.

The development of the cyclotron opened up vast new areas of research in nuclear science. It produced ions having considerably higher energies than those produced by any of its predecessors in beams of considerable intensity. Nuclear transformations even in the heaviest elements were produced with the cyclotron. A large variety of new radioactive substances was produced and isolated. It is fair to say that the whole important field of radioactive tracer technique in medical, biological and chemical research received a tremendous impetus as a result of the development of the cyclotron. The first tracer amounts of plutonium produced with the Berkeley cyclotron played an important role in the development of the plutonium bomb. By using the accelerated deuterons to bombard internal beryllium targets, neutron sources 50,000 times as intense as those obtainable previously from radon-beryllium mixtures were made available. Moreover, studies of the scattering of protons by protons and of neutrons by protons, carried out in an energy range otherwise inaccessible! advanced the knowledge of the interaction of the fundamental particles.

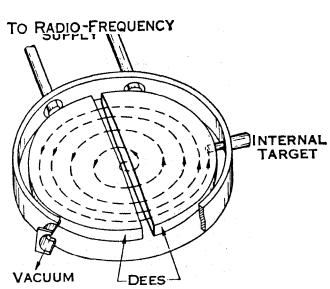


FIG. 6.—ARRANGEMENT FOR ACCELERATING IONS IN THE CYCLOTRON

In the cyclotron *(see* fig. 6) two semicircular (D-shaped) hollow electrodes, called dees, are arranged within a vacuum chamber

between the poles of a magnet. The ions starting near the centre circulate inside the electrodes, crossing the gap between them twice in each revolution. A high-frequency potential difference impressed across the dees will produce a repeated acceleration at each crossing, provided its frequency is very close to the circulation frequency of the ions.

It is necessary to keep the ions from striking the dees. By arranging for a small radial decrease in the magnetic field, a slight outward curvature to the magnetic field is obtained (see fig. 7). The magnetic force on the particle then always has a small component toward the median plane. This keeps the particle within an inch or two of the plane median to the two magnet poles. This is important because the total length of the spiral path which the ions traverse may be several hundred feet.

The necessity of this focusing, together with the effect of relativity in increasing the mass of the particle as its energy increases, makes inevitable a difference between the circulation of frequency of the particle and the oscillation frequency of the accelerating potential over a considerable portion of the path. Under these circumstances the particle will get out of step with the dee voltage. The effect accumulates with each revolution; and if very many revolutions are made the particle will ultimately arrive at a phase in which the voltage is of the opposite sign, which means that the particle will be decelerated. Thus, a large number of revolutions has to be avoided and a very high voltage must be put on the dees. An extreme example is the 86-in. cyclotron at the Oak Ridge National laboratory, Oak Ridge, Tenn., where a dee voltage of 500 kv. is used to accelerate protons to 22 Mev. This requires a 400-kw. oscillator and represents a practical limit to what can be obtained from a conventional cyclotron.

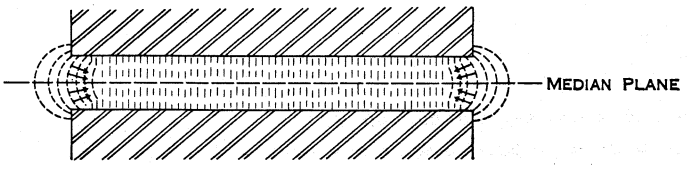


FIG. 7.— MAGNETIC FOCUSING IN THE CYCLOTRON

Arrows indicate direction of force on a particle moving in a radially decreasing magnetic field. The force is inward and toward the median plane

At the University of Washington, Seattle, a 60-in. cyclotron modeled after the one at the University of California was completed in 1952. It has a 200-ton magnet operating at a field strength of 15,000 gauss with a power input of about 60 kw. The radio-frequency oscillator operates with a power input of 125 kw. and develops a peak dee-to-dee voltage of 250 kv. In discussing the performance of cyclotrons it is important to distinguish between the internal circulating beam and that fraction of it which is extracted by means of a deflector. In the University of Washington cyclotron the internal beam has about 800 μ amp of 21-Mev deuterons. Thus, more than 12% of the oscillator power is converted to useful kinetic energy. About 25% of this beam can be extracted.

Some 50 cyclotrons are in use in research laboratories throughout the world. One-half of these are in the United States, and roughly an equal number are distributed throughout the world. These are of various sizes and some have special features. Thus; some of the more recent designs are arranged for easy changing of the energy. An example is the go-in. cyclotron installed at Livermore, Calif., which can accelerate protons from 2.6 Mev to 14.0 Mev; deuterons from 5.2 Mev to 12.j Mev; and tritons from 7.7 Mev to 8.3 Mev. Others are used largely for accelerating heavy ions. An example is the 1.2-m. pole diameter machine in Leningrad, U.S.S.R., which can accelerate nitrogen ions to 2j Mev.

The Oak Ridge National laboratory cyclotron produces what may be the world's record output of high-energy particles, 60 kw. of 22-Mev protons on an internal target.

Azimuthal Focusing.— In 1938, quite early in the period of cyclotron development, L. H. Thomas of Ohio State university described a means of obtaining additional focusing of the ions in the cyclotron by providing azimuthal variations in the magnetic field. This feature promised more stable and efficient operation of the machine in general, and a considerable improvement in the maximum energy attainable.

The idea was not taken seriously until 15 years later when an extensive study, both theoretical and experimental, was undertaken at the Radiation laboratory at Berkeley, Calif. Models were built, and these verified the soundness of the ideas. At Los Alamos, N.M.. the performance of the 42-in. cyclotron was greatly improved by the incorporation of Thomas focusing. This was accomplished rather simply by the insertion of three iron sector plates on the magnet poles. This kind of focusing can he augmented by spiraling the sectors. Such spiraled "hill and valley" magnetic fields appear to have useful applications in a variety of accelerator types for producing particles in the relativistic range of energy while using a fixed magnetic field and constant radio frequency. These designs were originated and have been developed extensively by the Midwestern Universities Research association (M.U.R.A.), Madison, Wis., under the name FFAG (fixed-field alternating-gradient accelerators).

Synchrocyclotron.—A more obvious way to overcome the energy limitation of the cyclotron is to provide a means of varying the frequency applied to the dees in accordance with the needs of magnetic focusing and the relativistic increase in the mass of the particle. The scheme is made practical by the existence of phase-stable orbits. Such an orbit is one in which the circulation frequency of the ion is the same as the oscillation frequency of the dee voltage. The circulation frequency of the ion decreases with increasing radius because of the decreased value of the magnetic field and the relativistic increase in the mass of the particle. When the frequency of the oscillator approaches the circulation frequency of the ion in the centre of the machine, some of these ions are caught into phase-stable orbits. As the frequency of the oscillator is decreased, the ions tend to stay in these orbits by absorbing energy from the electric field of the dees. By keeping in synchronism with the radio frequency, the particles gain energy and move in orbits of increasing radius up to the maximum allowed by the magnet design.

An important advantage of the synchrocyclotron is that, provided the vacuum is good enough, there is no limit to the number of revolutions the particle may make to obtain the desired energy. The desired acceleration may take place in quite small steps, 10 kv. per turn being the usual amount. This allows a more modest radio-frequency supply. Moreover, the shape of the magnetic field is much less critical. Another feature of the synchrocyclotron is the use of a single dee. This gives half the acceleration per turn of the two-dee system but has many mechanical and electrical advantages for synchrocyclotron use.

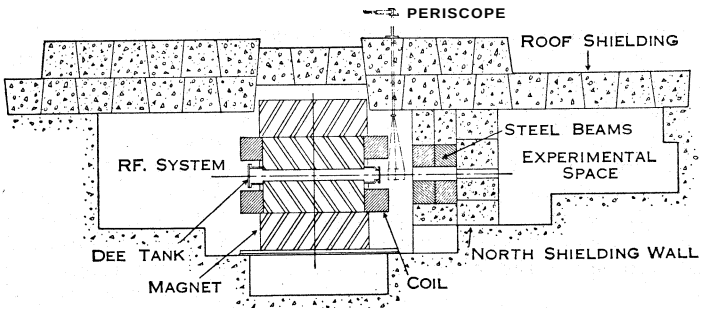


FIG. 8.— INSTALLATION OF THE 170-IN. SYNCHROCYCLOTRON AT THE UNIVERSITY OF CHICAGO

Heavy concrete and steel walls shield the working areas from the penetrating radiations emitted by ihe machine

On the other hand, the output intensity is much lower since the frequency is modulated. The ions are captured into stable orbits only during a small fraction of the modulation cycle. In the 170-in. synchrocyclotron at The University of Chicago, the beam appears as a pulse about 100 μ sec. long at a repetition rate of 60 cycles per second. The mean circulation current is about 2 μ amp. However, the energy is 450 Mev so the total beam power is almost 1 kw.

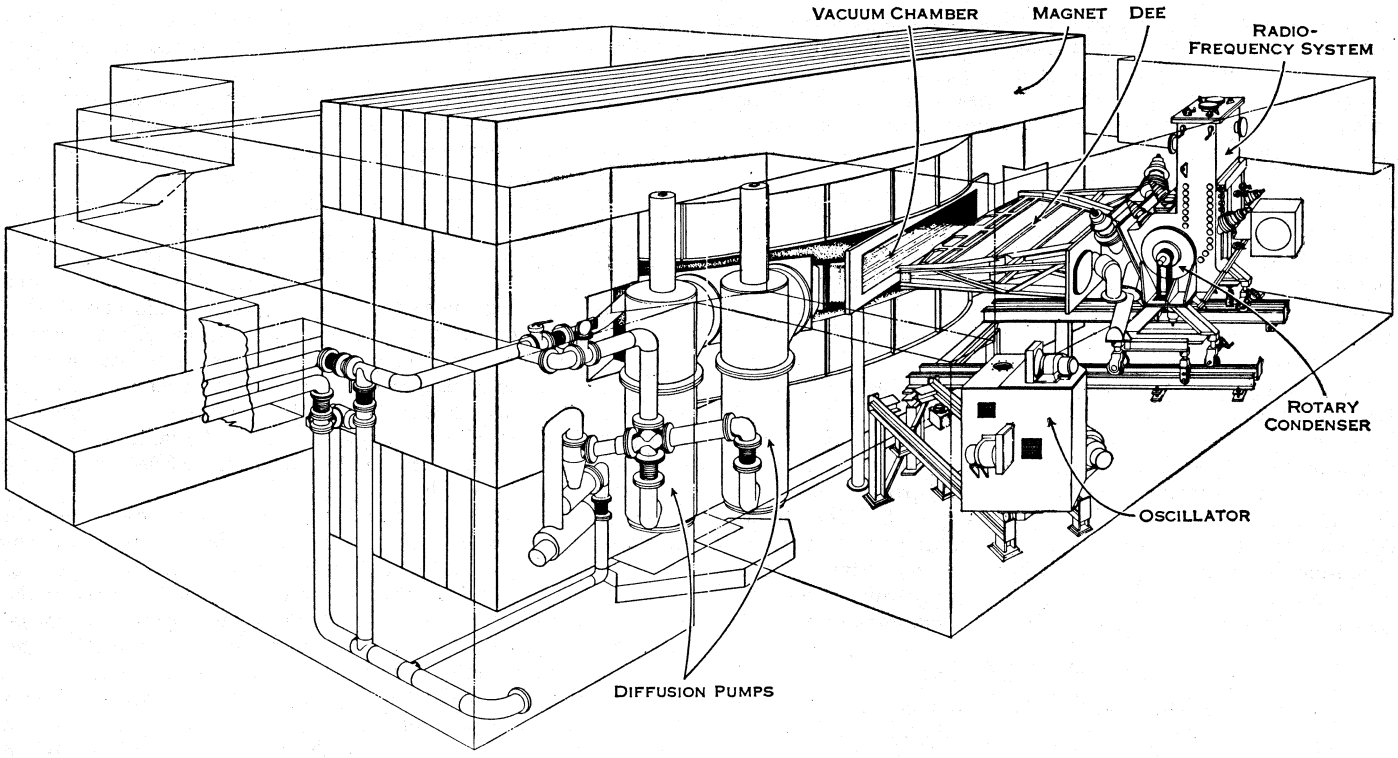


FIG. 9.— THE 170-IN. SYNCHROCYCLOTRON AT THE UNIVERSITY OF CHICAGO

The MacKenzie system of frequency modulation is used in which a rotating condenser changes the resonance frequency from 29 to 17 mc. per second

Following E. M. McMillan's suggestion, the first test of a frequency-modulated cyclotron was made by converting the 27-in. machine at Berkeley. The test was so successful that immediately afterward the 184-in. cyclotron, which was originally designed for conventional operation with about 1,000,000 v. on the dees, was operated as a synchrocyclotron and gave beams of about 200-Mev deuterons and 400-Mev alpha particles. In 1948 its radio-frequency system was changed to the MacKenzie circuit for operation with protons, and it then gave a beam of protons of an energy of 350 Mev. More recently (1957), an extensive conversion of both the magnet and the radio frequency brought the operating energy up to 750 Mev. This placed the Berkeley machine higher in energy than the 680-Mev machine in Dubna, U.S.S.R. (near Moscow), in operation since 1953; and the 600-Mev synchrocyclotron completed in 1958 in the laboratory of CERN (European Council for Nuclear Research) in Geneva, Switz. By the late 1950s about 16 synchrocyclotrons were in operation throughout the world, but only 8 of these gave energies above 200 Mev and were thus able to produce π mesons. For energies higher than 800 Mev the synchrocyclotron becomes too costly. Instead, synchrotrons turn out to be more practical for energies in the billion-volt range.

These machines have opened up important new possibilities for research into the nature of fundamental particles. Notable discoveries made with these machines include the artificial production of π mesons, the stripping of the deuteron, the polarization of the proton and the formation of π-mesic and μ-mesic atoms.

(H. L. AN.)

SYNCHROTRONS

Synchrotrons for Electrons. — The electron synchrotron utilizes the principle of phase stability to maintain synchronism between the circulating particles and an applied high-frequency electric field. A magnetic field deflects particles in a circular orbit, and the intensity of the field is modulated cyclically from low to high field strength as the particles gain energy, to maintain orbits of nearly constant radius. Since the magnetic field is required to maintain the orbit, but is not used for acceleration, magnetic field lines are needed only in the annular region defined by the orbit. This field may be produced by a ring magnet. The relatively low weight and cost of such a ring magnet compared with the solid-core magnets required for cyclotrons or betatrons gives the synchrotron a significant economic advantage for high particle energies.

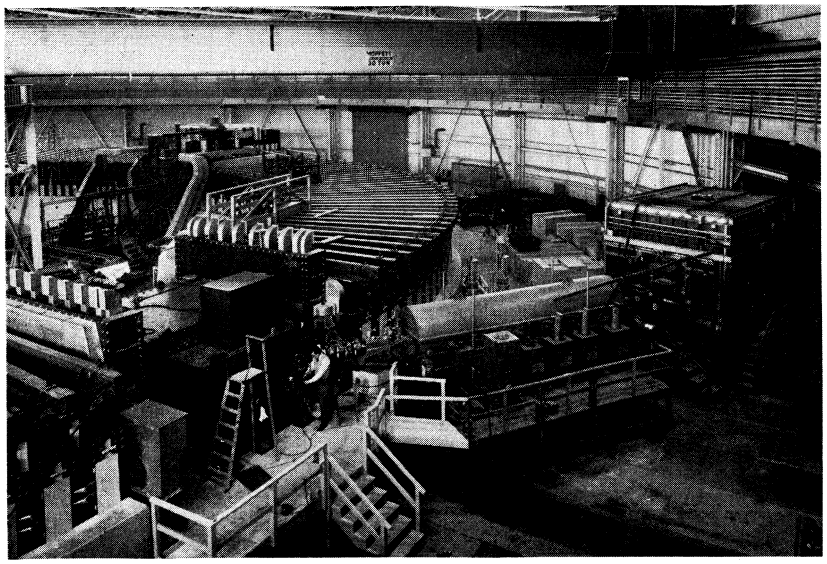
Electrons are well adapted to acceleration in a ring-shaped magnetic field, since they acquire a velocity essentially equal to the velocity of light at relatively low energies ($v = 0.98c$ at 2 Mev); for higher energies they circulate about an orbit of fixed radius at constant frequency. An electric field to provide acceleration is developed (by a resonant electrical cavity) across a gap in the vacuum chamber enclosing the orbit. The potential across the gap alternates at a frequency tuned to be identical with the orbital frequency of the electrons. This applied frequency is determined by the orbit radius r and is

$$f = \frac{c}{2\pi r} = \frac{\text{velocity of light}}{\text{orbit circumference}}$$

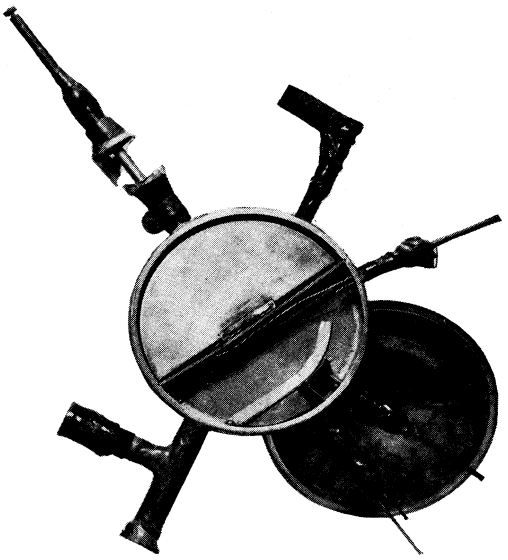
During the half cycle when the electric field is positive, the electrons acquire energy; they are reduced in energy during the other half cycle. So they become bunched into a phase where the voltage maintains a rate of increase in energy which matches the rising magnetic field. Under these conditions, an electron which crosses the gap at the wrong time, and which has the wrong energy, traverses an orbit of slightly smaller (or larger) radius. The resulting change in orbital frequency causes the electron to migrate toward the correct phase. This migration represents an oscillation in phase about the mean or equilibrium phase, at which the energy acquired per traversal is exactly that required to match the rate of rise of magnetic field. This type of stable-phase oscillation is inherent in the synchrotron. Electrons will follow any reasonable rate of rise of magnetic field; *i.e.,* 60 cycles per second. If sufficient accelerating potential is available across the gap, the electrons will maintain synchronism and be accelerated to maximum energy.

Electrons must be brought up to constant velocity (taken as 1 to 2 Mev energy) by some auxiliary means. In early synchrotrons this was accomplished by magnetic induction, as in the betatron, by providing some linkage flux threading the orbit. Other installations use a low-voltage accelerator external to the magnet to preaccelerate the electrons, after which they are inflected into the orbit by a suitably shaped electric field. The vacuum chamber has the general form of a toroid, or "doughnut," and must be main-

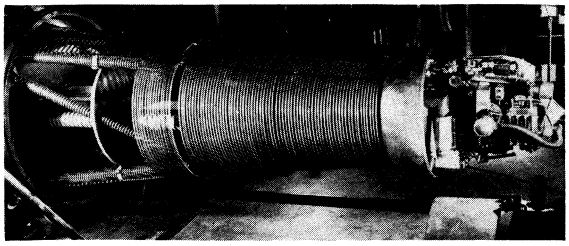
ACCELERATORS, PARTICLE



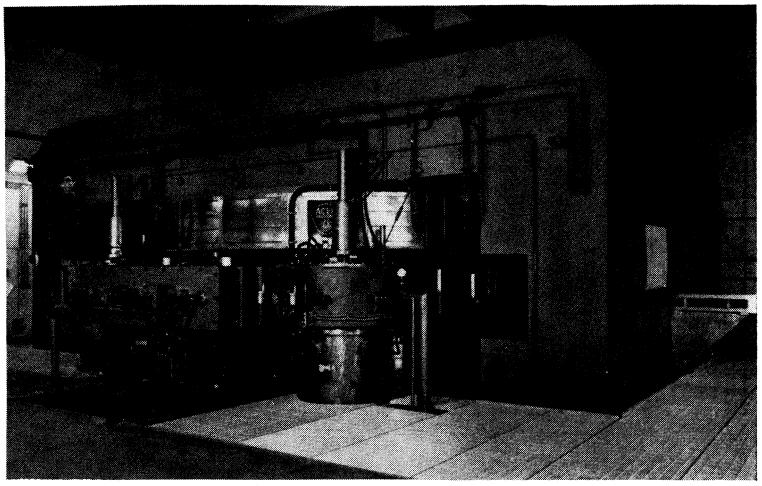
Bevatron at University of California. Cockcroft-Walton generator is at far right; linear accelerator, centre; part of magnet ring may be seen at left. Energy 6.2 BEV



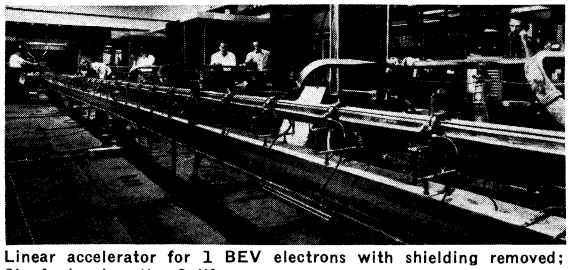
Cyclotron chamber of 1930 constructed at University of California by E. O. Lawrence and M. S. Livingston. Chamber diameter is about 5 in.



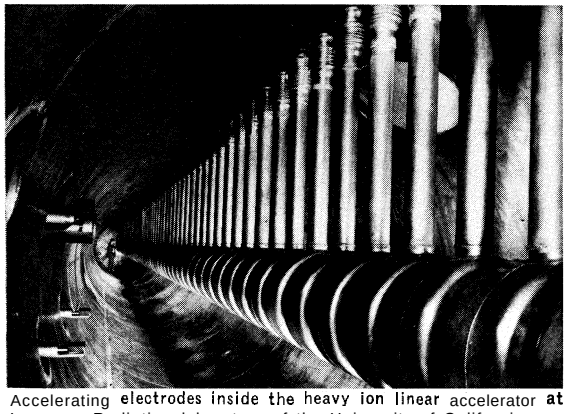
Van de Graaff generator for 4 MEV partially disassembled, showing high-voltage apparatus (right) and charging belt (left end)



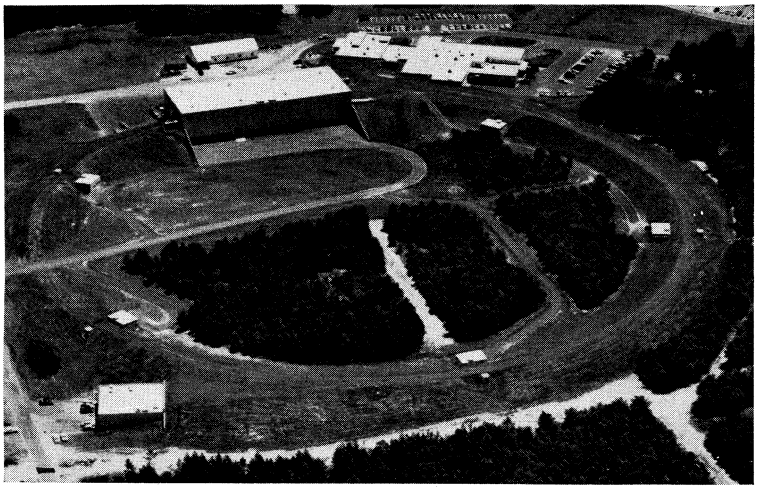
Synchrocyclotron designed for 600 MEV at Meyrin, Switz. Built for the European Organization for Nuclear Research (CERN)



Linear accelerator for 1 BEV electrons with shielding removed; Stanford university, Calif.



Accelerating electrodes inside the heavy ion linear accelerator at Lawrence Radiation laboratory of the University of California

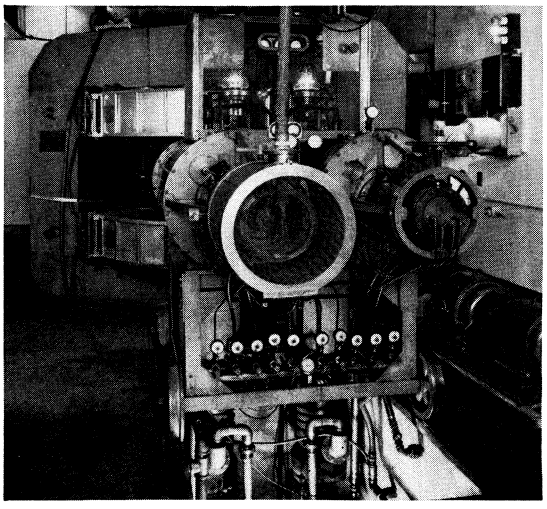


Alternating gradient synchrotron designed for 30 BEV protons, Brookhaven National laboratory, N.Y. The magnet is housed in a circular tunnel with a circumference of one-half mile

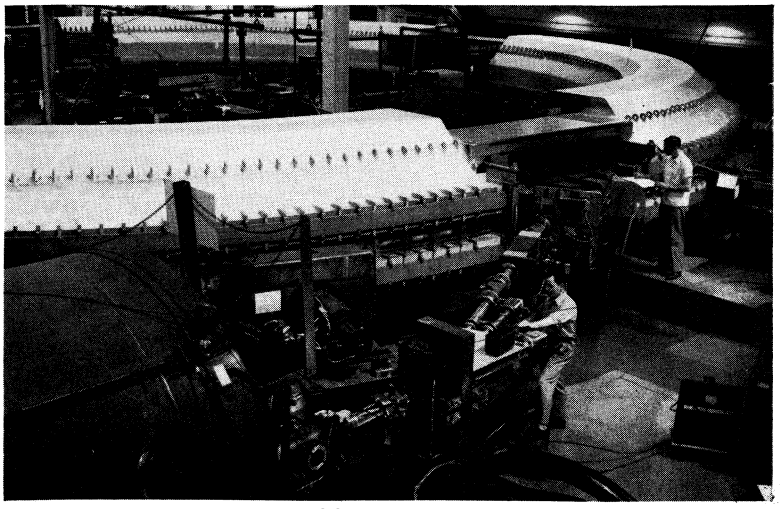
VARIOUS TYPES OF ACCELERATORS IN THE U.S. AND SWITZERLAND

BY COURTESY OF (TOP LEFT CENTRE LEFT ABOVE. BOTTOM LEFT1 UNIVERSITY OF CALIFORNIA. LAWRENCE RADIATION LABORATORY, (TOP RIGHT) U.S. ATOMIC ENERGY COMMISSION, (CENTRE RIGHT) CERN CENTRE LEFT BELOW) STANFORD UNIVERSITY. (BOTTOM RIGHT) BROOKHAVEN NATIONAL LABORATORY

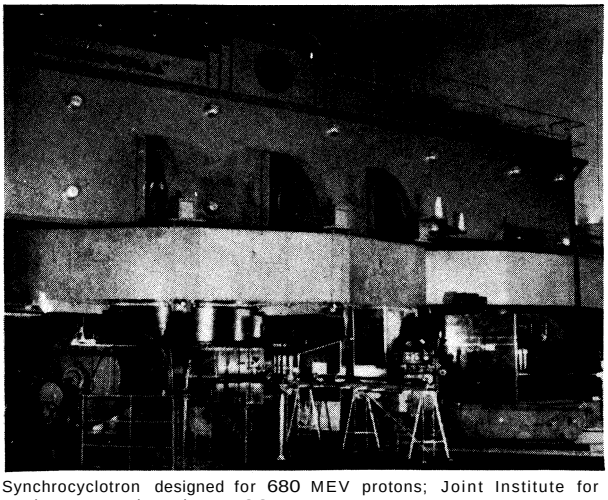
ACCELERATORS, PARTICLE



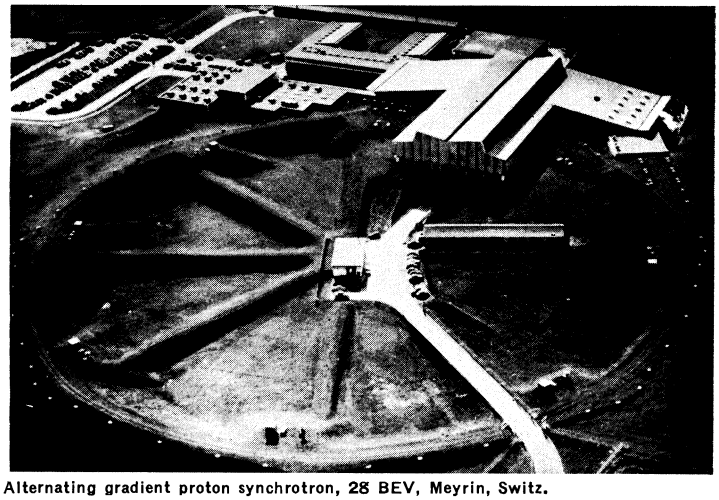
Fixed frequency cyclotron (42 in.); Massachusetts Institute of Technology



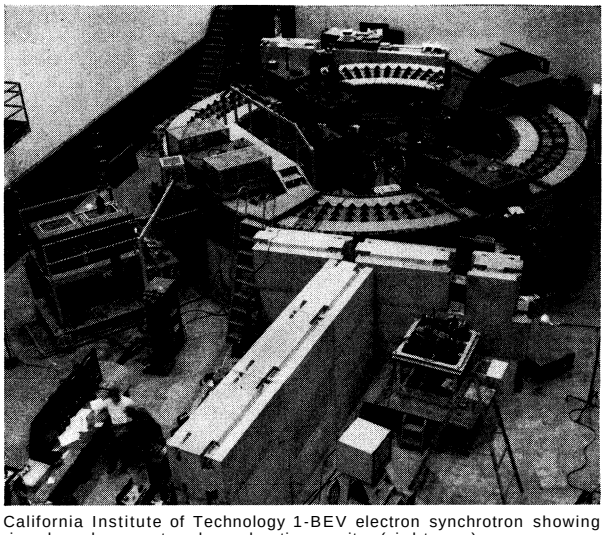
Cosmotron, a proton synchrotron for 3.2 BEV, Brookhaven National laboratory, seen from angle at which protons enter vacuum chamber



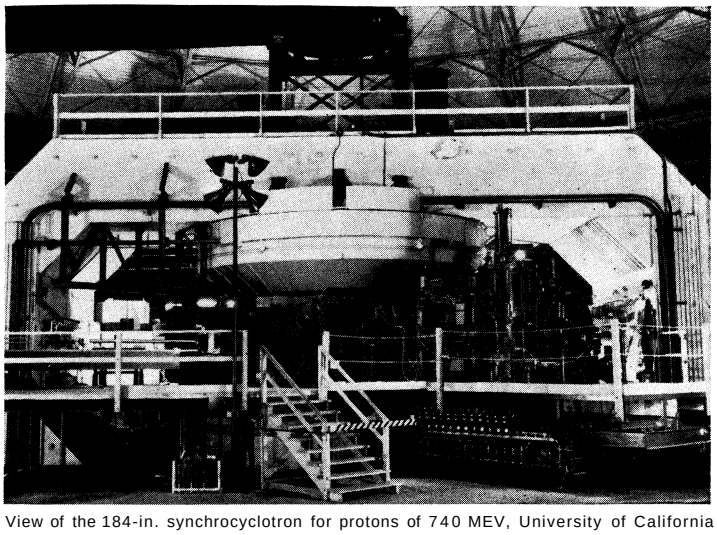
Synchrocyclotron designed for 680 MEV protons; Joint Institute for Nuclear Research, Dubna, U.S.S.R.



Alternating gradient proton synchrotron, 28 BEV, Meyrin, Switz.



California Institute of Technology 1-BEV electron synchrotron showing ring-shaped magnet and accelerating cavity (right rear)



View of the 184-in. synchrocyclotron for protons of 740 MEV, University of California

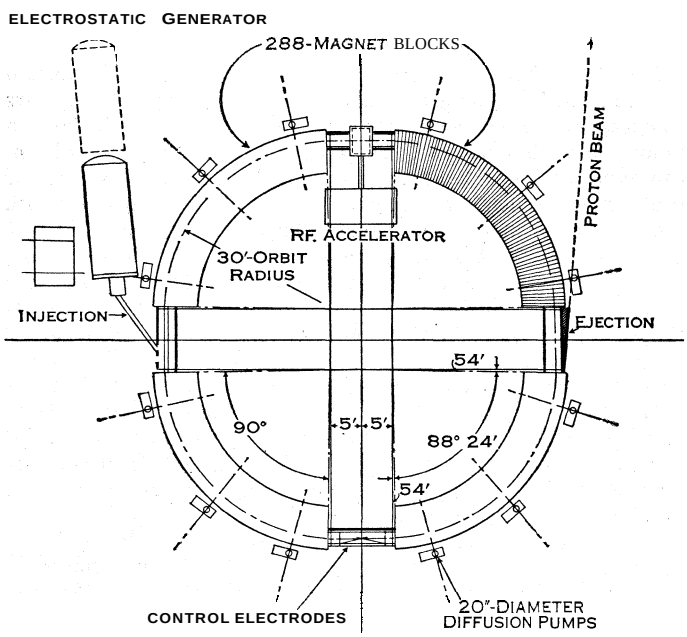
CYCLOTRON, COSMOTRON, SYNCHROTRONS AND SYNCHROCYCLOTRONS

BY COURTESY OF (TOP LEFT) NUCLEAR SCIENCE LABORATORY M I T . (TOP RIGHT) BROOKHAVEN NATIONAL LABORATORY (CENTRE LEFT) THE JOINT INSTITUTE FOR NUCLEAR RESEARCH. DUBNA, U S.S R (BOTTOM RIGHT) UNIVERSITY OF CALIFORNIA, LAWRENCE RADIATION LABORATORY, (BOTTOM LEFT CALIFORNIA INSTITUTE OF TECHNOLOGY. PHOTOGRAPH, (CENTRE RIGHT) WIDE WORLD

tained at high vacuum (0.000001 mm. Hg) to avoid loss of electrons by scattering from the gas during the early stages of acceleration. When the electrons approach maximum energy, the oscillator providing the high-frequency accelerating field is turned off; the electrons spiral in to strike a target on the inside of the chamber and generate a narrow beam of energetic X-rays which emerge tangentially from the chamber and which can be used for experimentation.

The first electron synchrotron. for 8 Mev, was built in England in 1946 to test the principle of phase-stable acceleration. The first high-energy synchrotron developed 330 Mev in 1947, at the University of California. By 1956 more than 20 synchrotrons between 50 and 500 Mev were in use as research instruments in many countries. Two synchrotrons for 1,200 Mev were completed in 1957, one at the California Institute of Technology, Pasadena, and one at Cornell university, Ithaca, N.Y. The Cornell machine was the first of a new type of synchrotron using alternating-gradient magnets (see below, Synchrotrons for Protons). Electron synchrotrons have found their greatest use as X-ray sources for producing photonuclear reactions, especially the photoproduction of mesons, which occurs above a threshold of about 250 Mev. Synchrotrons of 100 Mev or less have also found useful applications in hospitals for treatment of cancer and in nuclear research laboratories.

The electron synchrotron has a unique property which leads to a practical upper limit of energy. When deflected in a magnetic field the electrons radiate electromagnetic energy in a continuous spectrum extending into the soft X-ray region, with an intensity which increases with the third power of electron energy. This radiated energy must be supplied by the high-frequency accelerating system, in addition to that required for synchronous acceleration. At very high energies the radiation disturbs particle orbits and produces transverse oscillations which throw the electrons out of the chamber. The Cambridge electron accelerator, a joint project of the Massachusetts Institute of Technology and Harvard university, is designed to produce electrons at an energy of 6,000 Mev (6 Bev), which approaches the practical energy limit. It uses alternating-gradient magnets in an orbit 236 ft. in diameter, operating at 60 cycles per second, and has many high-frequency accelerating cavities to provide the energy lost by radiation. A similar electron accelerator was under construction (1960) in the DESY project at the University of Hamburg in west Germany.



FROM M. H. BLEWETT, "THE COSMOTRON: A REVIEW," REV. SCI. INSTRUM., 24.727 (1953)

FIG. 10.— PLAN VIEW OF THE COMPONENTS OF THE COSMOTRON, A 3-BEV PROTON SYNCHROTRON AT THE BROOKHAVEN NATIONAL LABORATORY, UPTON, L.I., N.Y.

Synchrotrons for Protons. — The proton synchrotron also uses a ring magnet and utilizes the principle of phase stability to maintain synchronism with the high-frequency accelerating electric field. A ring magnet is much lighter and less costly than the solid-core magnet of a synchrocyclotron, which also accelerates protons, but requires acceleration at essentially constant orbit radius. The magnetic field must be varied cyclically from low to high field strengths during the acceleration interval, matching proton energy. High-energy protons are produced in short bursts at the peak of each cycle, which results in a low average beam intensity. However, the advantage of higher energies for scientific research justifies reduced beam intensity, and proton synchrotrons have displaced synchrocyclotrons for energies above 1 Bev ($= 10^9$ electron volts).

Proton velocity increases continuously with increasing energy; so, unlike the situation with electrons, orbital frequency increases during acceleration, by more than 1:10. The applied electric field must be varied in frequency to match exactly the orbital frequency of the protons, which requires a precisely determined schedule of frequency modulation. To vary the frequency, the resonant cavities which provide accelerating electric fields are equipped either with rotating capacitors or with ferrite cores which are magnetically biased, or with both. In high-energy accelerators many such cavities are spaced around the orbit and operated in phase.

Protons are preaccelerated in an external accelerator to relatively low energy, and are inflected into the orbit when the orbit magnetic field reaches the proper value for deflection at the designed radius. At maximum energy the protons are directed against targets at the edge of the chamber by changing the applied frequency, or they can be deflected tangentially outward in an emergent beam for experimental studies.

The cosmotron at Brookhaven National laboratory, Upton, L.I., N.Y. (see fig. 10), completed in 1952, operates at 3 Bev and produces bursts of 5×10^{10} protons at 5-sec. intervals. The magnet is formed of four quadrants spaced by 10-ft. straight sections, forming a distorted circle of 75-ft. diameter. An electrostatic generator produces 4-Mev protons, which are inflected into the orbit at one straight section. A ferrite-loaded high-frequency resonant cavity in another straight section supplies about 3,000 v. per turn for acceleration and is modulated between 0.37 and 4.20 mc. per second. At high energy the protons are deflected outward in an emergent beam used for experiments. Significant research has been performed on the production of "strange" particles and the properties of high-energy mesons.

The bevatron at the Berkeley Radiation laboratory was completed in 1954. It produces 2×10^{10} protons per pulse of 6.2-Bev energy, at 10-sec. intervals. The magnet consists of four quadrants with 20-ft. separation, forming a circle of 160-ft. diameter. Protons are preaccelerated to 0.5 Mev in a Cockcroft-Walton generator and to 10 Mev by a linear accelerator, before being inflected into the orbit. Although structurally larger and heavier than the cosmotron, the bevatron is similar in basic principles of design and of operation. Research operations have been highly successful, the most dramatic results being the discovery of the negative proton (antiproton) and the antineutron.

The principle of alternating-gradient magnetic focusing, developed at Brookhaven starting in 1952, has been applied to several types of accelerators. It utilizes alternately positive and negative gradients in the magnetic field used to deflect particles around an orbit. A gradient field is one in which the field is stronger on one side of the orbit than on the other, so magnetic field lines are curved, and particles are deflected toward or away from the median plane and the central orbit. In effect, the successive sectors of alternating gradient are magnetic "lenses" which focus moving particles strongly about the chosen equilibrium orbit location. The use of such strong focusing fields reduces particle oscillation amplitudes, allowing much smaller magnets to be used and so reducing cost. Synchrotrons can be designed for larger orbit radii and higher energy.

An alternating-gradient proton synchrotron at the CERN laboratory in Geneva was brought into operation in 1959 at 28 Bev. and a similar machine at Brookhaven was completed in 1960. These

super-energy accelerators are located in underground circular tunnels for radiation shielding; that at Brookhaven is 750 ft. in diameter. Scientists anticipate an exciting wealth of new experimental information on the properties of high-energy particles when these machines come into full operation. (M. S. LN.)

LINEAR ACCELERATORS

Linear Accelerators for Electrons. — The term linear accelerator might be applied to any machine which accelerates particles in a straight line, but through common usage it has been restricted to the particular class of these machines which employs repeated use of a rapidly alternating potential in a resonant condition. It is a development and extension of the machine proposed by R. Wideroe, mentioned above under *Resonance Accelerators*. Because of the considerable difference in the design and operation of these machines for electrons and for heavy particles, they will be treated separatelv.

Linear accelerators were developed through the application of techniques developed by the radar programs of World War. II. With few exceptions, they use an electromagnetic (or radio) wave with a frequency of the order of 3,000 mc. per second traveling down an evacuated wave guide as the medium of acceleration. A wave guide is a cylindrical pipe with conducting walls in which a radio wave may be propagated under suitable circumstances. Electrons are injected into the wave guide so that they travel in the same direction as the wave; and the wave guide is so constructed that the principal wave and the particle have the same velocity at all points along the guide. The wave guide is also arranged so that the electric field component of the wave is directed along the axis. Electrons entering the guide at the proper time (or phase) experience a force resulting from the interaction of their charge and the electric field; and since wave and particle travel at the same speed, this force continues throughout the length of the wave guide, accelerating the electrons to ever-increasing energies. The effect is similar to that of a surfboard rider on an ocean wave.

There are several possible conditions of phase for acceleration. The particle can be ahead of the point of maximum electric field in the wave. In this case it is phase stable, for if the acceleration is not sufficiently large to keep the electron in step with the wave, the electron moves back to a position of greater field and greater acceleration. It can be shown, however, that the electron is then radially unstable; *i.e.,* if the electron is deflected from its path, the deflection becomes progressively worse. The particle can also be behind the position of maximum electric field. It is then phase unstable and radially stable. As a third condition, the particle may be at the position of maximum electric field (which incidentally has a sine wave variation). In this case, it is in unstable equilibrium in regard both to phase and radial deflections.

Since it is not possible to fabricate the wave guide so that the wave will have exactly the right velocity, it is generally advantageous to operate the machine so that the electrons have phase stability and to overcome the radial instability with an axial magnetic field along the guide. In one notable case, however, the position of unstable equilibrium is used (the accelerator developed at Stanford university, Stanford, Calif.). The rate of acceleration is very high; the wave velocity is made equal to the velocity of light; and, because of the relativistic velocity of the particles, the accelerator appears so short that neither phase nor radial instability has a chance to operate.

In an ordinary wave guide with smooth conducting walls, the phase velocity of the electromagnetic wave is always greater than the velocity of light. Since particle velocities cannot exceed the velocity of light, it is necessary to slow the wave down. This is accomplished by placing iris diaphragms in the guide. Thus a practical accelerator wave guide consists of a metal tube of high conductivity and circular cross section with metal diaphragms placed at intervals of one-fourth wave length throughout the length of the tube. Each of these diaphragms has a circular opening at its centre through which the electrons pass. The phase velocity of the wave is determined by the difference between the diameter of the hole in the diaphragm and the inside diameter of the tube.

The final energy of electrons from a linear accelerator of optimum design is proportional t~ the square root of the product of wave-guide length and radio-frequency power input. Since the cost of long accelerator wave guides is very large, the power input must be as high as possible. Magnetrons operating at power levels of 500,000 to several million watts, and klystrons operating in the range of 10,000,000–30,000,000 w. have been used as power sources. These tubes are unable to handle such power continuously and therefore are turned on for periods of one or two millionths of a second, repeated 50 to 1,000 times per second.

Since magnetrons are free-running oscillators, it is very difficult to control the phase so as to operate several together. On the other hand, klystrons are power amplifiers, and it is easy to drive any number from a single source with complete control of the phases of the output. This fact makes possible the cascading of a number of separate sections of accelerator with each feeding into the next section with the proper phase. This scheme was adopted at Stanford university for acceleration to the 1,000-Mev (1-Bev) range. (L. S. Ss.)

The first linear accelerator was built by D. W. Fry and his associates at Malvern, Eng., in 1946. Further work continued in England and to some extent in the United States on obtaining large output currents and high efficiencies. A single magnetron feeding several feet of wave guide with magnetic focusing was used in this first accelerator. Subsequent accelerators were built in England, France and the United States that employed several klystrons feeding separate sections to obtain higher energies. In some of these machines, peak currents as high as 0.75 amp. have been obtained, with as much as 50% of the radio-frequency power being transferred to the electron beam. Some of these high-current accelerators are intended to generate pulsed neutrons for time-of-flight measurements. Others are intended for use in food and drug sterilization and for activation of chemical reactions. A number of lower-current accelerators are also in use as X-ray sources in the range of 4–6 Mev for the treatment of cancer. There are several machines in the range of 50 Mev being used for biological research and experimentation in the direct use of electrons for cancer treatment.

By the late 1950s, there was only one linear accelerator in operation for producing extremely high-energy electrons. This machine, at Stanford, was started by W. W. Hansen and completed by E. L. Ginzton and his associates. It ran for a number of years at energies in the range of 700–800 Mev and was found to be a unique research tool for nuclear physics. Since the electron beam can easily be brought out from the accelerator, certain types of precision experiments can be performed which are not possible with the circular machines from which such removal is very difficult. The high currents that are available also permit energy sorting which is another asset in nuclear experimentation. By 1959, the Stanford machine had'been extended from a length using 21 klystrons to one using 30 klystrons so that electrons of 1-Bev energy could be achieved. (M. Cw.)

Linear Accelerators for Protons. — Linear accelerators for protons are so different from those for electrons in principle of operation, design and appearance that the two must be treated separately. The essential similarity is the resonant use of a radio-frequency voltage; the resonant principle appears, however, much more explicitly in the proton accelerator.

The great difference between the two accelerators is due to the large difference in mass of the two particles to be accelerated, the proton being 2,000 times heavier than the electron. Whereas an electron has a velocity which is nearly constant and equal to that of light at energies higher than 1 Mev, a proton is much slower and essentially obeys the classical laws of mechanics up to 100 Mev; that is, its velocity increases as the square root of its energy. This low velocity of the proton makes it impractical to reduce the velocity of an electromagnetic wave in a wave guide to the extent needed to use the principle of the electron linear accelerator. It is necessary to develop a new technique for protons.

Consider a large cavity in the form of a long, cylindrical tank with electrically conducting walls. When this cavity is fed with

radio-frequency power of the proper frequency, a resonant condition is set up The cavity is equivalent to a wave guide with closed reflecting ends, so that the wave is reflected from side to side, resulting in a standing wave at the resonant frequency much the same as a sound wave in an organ pipe. The cavity and the way in which power is fed are so designed that the electric field of the electromagnetic wave is in the direction of the long dimension of the cavity. Therefore, if protons are injected with the right phase in the direction of the long axis of the cavity. they will be accelerated at first; but when the phase of the oscillation changes, they will be decelerated. The result is no net gain in energy. To avoid this difficulty, a number of hollow drift tubes are placed nearly end to end along the axis of the cavity. These shield the protons while they are within the tubes from the effects of the decelerating field. The lengths of the drift tubes are so adjusted and the gaps between so placed that the protons cross the gaps at the time the field is near a maximum in the accelerating direction. This requires the spacing between drift-tube centres to increase as the proton is accelerated; the distance being v/f, where v is the velocity of the proton and f is the frequency of the electromagnetic wave.

In proton linear accelerators. the particles must have the proper velocity at each gap. The machine will not operate unless the radio-frequency power level is above a minimum value. This disadvantage is not shared by the electron accelerator; but, on the other hand, the energy spectrum of the proton accelerator is much better (*i.e.,* the spread of energies of the emergent particles is much less).

The drift tubes must have sufficient diameter to pass a reasonable beam of protons, but at the same time they must not be so large that there is appreciable penetration of the electromagnetic field into their interior. This leads to the use of relatively low frequencies — in the region of 200,000,000 cycles per second. The large size of the cavity leads to a long time for the build-up of resonant oscillations, requiring a long pulse of power. This is an advantage in nuclear disintegration work.

There are positions of phase stability and radial instability, or phase instability and radial stability, as in the linear accelerator for electrons. The radial instability can be eliminated by placing metallic grids across the drift tubes, changing the shape of the electric field in the gap region to one that has a focusing action.

Wideroe's two-stage linear accelerator was developed by E. O. Lawrence and D. H. Sloan, who built several multistage accelerators in 1930–32. The logical extension of their ideas to the acceleration of protons was accomplished by L. W. Alvarez and his associates at the University of California in 1947. As in the electron accelerator, this accomplishment was materially aided by the very extensive technical advancements in radar during World War II. The California accelerator operates at a wave length of 150 cm. The cavity has a diameter of 3.5 ft. and a length of 40 ft. Protons are injected from a Van de Graaff generator at 4 Mev and accelerated to 32 Mev. The 2.5 megawatts of radio-frequency power comes from six triode oscillators which are pulsed on for 500 μ sec., 15 times per second. The average beam current is $\frac{1}{3}$ μ amp. (L. W. A.; L. S. Ss.)

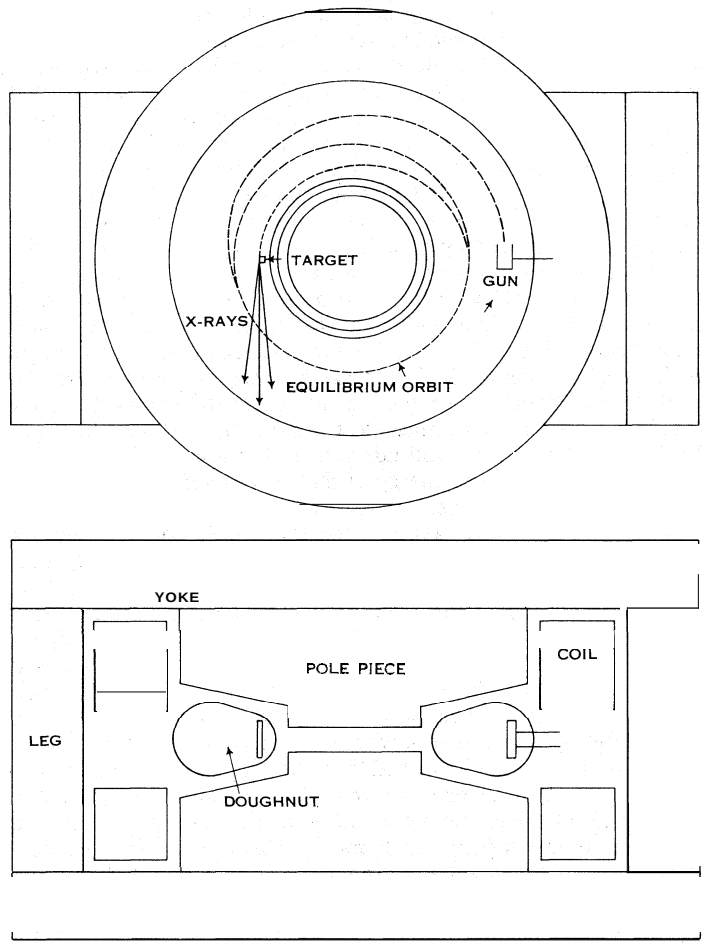
A second proton machine, operating at 60 Mev, was built at the University of Minnesota, Minneapolis, by J. H. Williams. In addition to these two machines intended for nuclear research, a number of proton accelerators were built as injectors for circular accelerators. Examples are at Berkeley and Brookhaven in the United States, at several Russian laboratories and at CERN in Geneva, Switz.

Another interesting application of linear accelerators is exemplified by two heavy ion accelerators at the University of California and at Yale university. These will accelerate a variety of ions, with energies of the order of 10 Mev per nucleon. These are also intended for bombardment experiments using such heavy nuclei as carbon, nitrogen, oxygen, etc. See also NUCLEAR ENGINEERING. (M. Cw.)

BETATRONS

The betatron is a circular accelerator for electrons, operating on the same principle of electromagnetic induction as the transformer. It produces electrons or X-rays of millions of electron volts of energy without the use of excessively high voltages. The need for such a machine is threefold: (1) in nuclear physics a source of high-energy electrons or X-rays is used to study fundamental properties of matter and radiation; (2) in industry the X-rays are used in radiography, where they are able to penetrate 12 in. of steel and still produce a good radiograph; and (3) in medicine X-rays of high penetrating power, producing a low skin dose and a high depth dose of radiation, are valuable for the treatment of cancer.

Description. — In a transformer the electrons in the secondary winding are guided by the insulated copper wire wound around the core, while the changing magnetic flux in this laminated iron core induces a voltage in the secondary winding that makes the electrons move. Similarly in the betatron there is a means of guiding the electrons along their circular path; at the same time they are accelerated by the electric held induced by changing magnetic flux within the orbit. However, the guiding process in the betatron is quite different: in the first place, the circular orbit is inside a high-vacuum tube in the form of a hollow glass or ceramic "doughnut"; in the second, the electrons are kept in the circular orbit or focused toward it by a specially shaped magnetic guide field. The magnitude of this field must be in a definite proportion to the magnetic flux through the orbit so that the circular path does not become either a decreasing or an increasing spiral. By traveling around the tube thousands of times the electrons build up a high energy measured in millions of electron volts, without the insulation problems associated with the actual production of a high potential.



BY COURTESY OF GENERAL ELECTRIC CO.

FIG. 11.— HORIZONTAL CROSS SECTION (TOP) AND VERTICAL CROSS SECTION (BOTTOM) THROUGH BETATRON

The upper part of fig. 11 is a horizontal cross section through

the centre of the betatron. The dotted line gives a rough indication of the path of an electron in the vacuum tube: starting from the electron gun, the electron goes thousands of times around at the equilibrium orbit and finally stops at the target where X-rays are produced, these being principally in the direction of the motion. The lower part of fig. 11 is a vertical section showing the magnetic circuit with the coils forming the primary winding and the doughnut representing the secondary. As can be seen, the magnetic guide field at the orbit and the magnetic flux passing through the orbit belong to a magnetic circuit. This consists of two specially profiled round pole pieces, two horizontal yokes and two vertical legs. All these parts are made of laminated silicon steel to keep eddy-current losses low. The frequency of operation ranges from the power-line frequency of 50 or **60** cycles per second to as high as **2000** cycles (in which case a motor generator is required). The magnetic circuit is energized by means of two primary windings which are connected to the power source in shunt with a capacitor bank. The capacitor bank is used to increase the power fgctor. The vacuum tube (or doughnut) is located between the profiled part of the pole pieces; its inside wall has a thin, high-resistance coating to keep static charges from disturbing the electron beam.

Electrons are introduced into the vacuum tube by an electron gun placed in the plane of the stable orbit and usually outside it. It is placed as far from the equilibrium orbit as possible in order to leave a maximum of unobstructed space, yet within the region where the magnetic field has the proper focusing effect. The electron gun is a small metal box with a slot through which the electrons emerge. They originate inside the box at a hot filament or other thermionic emitter. The emitter is provided with shielding and focusing electrodes so that when the filament is given a negative potential with respect to the box the emitted electrons are accelerated toward the slot and shot into the tube in the form of a narrow, directed beam. To avoid disturbances from electric fields outside the gun, the metal box or gun anode is grounded and connected to the conducting coating inside the doughnut. Electric fields of unwanted electrons from the space charge are minimized by applying the accelerating voltage to the gun filament for only a few millionths of a second. This pulse of the order of **50,000** v. is timed to occur after the magnetic field has passed through zero and at the instant the field has the proper magnitude and direction to guide the electrons into circular paths inside the doughnut. Many of the injected electrons strike the walls of the doughnut or the gun structure during the first few revolutions. The remaining electrons oscillate about the equilibrium orbit with an amplitude which decreases as the magnetic field gets stronger. The energy of the electrons rises, the rise continuing as long as the field increases.

When the electrons have reached the proper energy, they are made to strike a target to produce X-rays. This is done by suddenly upsetting the relationship between guide field and flux, which so far has kept the orbit circular. The simplest method is to allow the iron in the centre of the betatron to saturate, whereupon the guide field increases at a faster rate than the flux, and the electrons spiral inward toward the target. Another method is to pass a high-current pulse through a turn of wire wrapped around the central iron core within the orbit, so that the ratio of flux to guide field is diminished, and the electrons spiral in to the target. This type of orbit contraction is usually timed to occur at the peak of the sinusoidal variation of the magnetic field, since the electron energy is at a maximum at this time. After the electrons have hit the target and produced a short burst of X-rays, no electron acceleration takes place for the remaining three-quarters of the cycle. The useful current striking the target is of the order of a few microamperes.

Some betatrons are equipped to produce an external beam of electrons instead of X-rays. In this case the electron gun may be placed inside the equilibrium orbit. Near the outside of the doughnut is located an electrostatic or electromagnetic deflection system which, upon orbit expansion, directs the electrons toward and through a thin metal-foil exit window. The external electron beam has some use in physics research and cancer therapy.

Particle Dynamics. — The equations of motion of the electron in the radial direction and the tangental direction may be integrated, subject to the constraint of constant radius. Elimination of charge and momentum yields the required relationship between magnetic flux through the orbit and the guide field at the orbit. This condition is

$$\phi - \phi_0 = 2\pi r^2 B$$

Expressed in words, the equation states that the change of the magnetic flux $(\phi - \phi_0)$ from the time that the guide is zero is equal to twice the product of the area (πr^2) of the circular orbit and the flux density (B) in the guide field. In most betatrons, $\phi_0 = 0$, and the equation then shows that the flux density averaged over the orbit is twice the guide-field flux density. Therefore the guide field is relatively weak even when the iron in the centre of the machine tends to saturate. A great weight and size reduction is obtained in the so-called biased betatron by making ϕ_0 negative; this is done by means of a bias winding and appropriate currents. One of the remarkable things about the equilibrium orbit is that it does not change form as the velocity of the particle changes from the nonrelativistic to the extreme relativistic region. It is this fact which makes the betatron so simple a machine for electron acceleration, since injection occurs at low velocities, and acceleration is carried to velocities very close to that of light. It is only when the betatron principle is applied beyond 100 Mev that the above relation is insufficient to maintain a circular orbit. With this high energy an electron in circular motion radiates so much electromagnetic energy, including visible light, that the loss of energy (unless compensated for by additional magnetic flux) causes an appreciable contraction of the orbit.

For energies larger than a few million electron volts the kinetic energy of the electrons in a betatron can be given by a simple expression:

$$E = 3 \times 10^{-4} Br - 0.51$$

where E is the kinetic energy in millions of electron volts (Mev); B is the flux density at the orbit in gauss; and r is the orbit radius in centimetres. Practical values of B range from 2,000 to 8,000 gauss, depending on the size and on the use of bias.

History and Present Status. — The successful operation of a betatron was first demonstrated by D. W. Kerst at the University of Illinois, Urbana, in 1940. The concept of the equilibrium orbit was known many years before that time, but the careful theoretical study by Kerst and R. Serber of the conditions for injection and Kerst's use of the pulsed electron gun placed near the equilibrium orbit made the betatron practical.

Betatrons are now in commercial production in the U.S. and Europe in the energy range from 10 to **30** Mev. Most betatrons are in industrial radiographic use; a few are being used in cancer therapy; and some, including the largest, rated **300** Mev, in high-energy physics research. Above 50 Mev the betatron was superseded by the development of the synchrotron in **1946.**

(W. F. WP.)

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ACCENT, in speech, is understood colloquially in at least three senses: (1) the presence in an individual's speech of articulations not typical of the community (*e.g.*, a foreign accent); (2) a sustained quality of vocalization, outside the linguistic system, used to discriminate shades of meaning or personal characteristic (*e.g.*, to speak in tender accents); (3) a prominence given to a short span of speech and manifested as stress or pitch or some extralinguistic component.

In linguistics, accentual (also called prosodic or suprasegmental) features are sound units which may be manifested as pitch or tone (*i.e.*, acoustic fundamental frequency), stress (intensity), length or quantity (duration), and occasionally as glottalization, devoicing or nasalization.

In English, the most widely used notations for stress are: ˈ for primary stress; ˆ for secondary stress; ˋ for tertiary stress; and ˘ for weak stress. Different stresses applied to the same words convey difierent meanings. For example, the same four words, "a-black-bird's-nest," according to their stress sequence may convey the following: ˘ ˆ ˋ ˊ a *nest* (not a house) of a blackbird: ˘ ˊ ˋ ˆ a nest of a blackbird (not a jay); ˘ ˆ ˆ ˊ a nest of a black bird; or ˘ ˊ ˆ ˋ a bird's nest that is black (not green). The difference betneen the tertiary and weak stresses is further exemplified by comparison of the final syllables in "Andès" and "cándiěs" or "pick-ùp" and "híccoŭgh." Pitch notation consists of numbers from 4 (for the highest) to 1 (for the lowest). Differences in pitch sequence in the word "yes" may convey the following: 4–1, impatient agreement. as after persistent urging; 2–3, abruptness, as in answer to an interruption; 3–2, apprehensive admission or concession; 4–4, high-pitched frightened acquiescence; 2–4–1, leering, lascivious approval or conniving agreement. Cut-offs are indicated as follows: ↓ sharp; ↑ up-glide; and → trail-off. The word "well," depending upon the cut-off, may indicate the following: 2–2 ↓, "let's get on nith it"; 2–2 ↑, "and then—?" or "please explain yourself"; and 2–2 →, preoccupied indecision. (These examples are characteristic of a great many residents of the U.S., particularly in the north and east, but are not, of course, valid for all English-speaking persons)

Accents form perhaps the most common basis in languages for the organization of syllables, most commonly by stress and pitch. While English seems to have four degrees of stress, one of which occurs nith every vowel, Chinese has four tones, one of which occurs with most syllabics. Occasionally (*e.g.*, in Swedish) the pitch organizes a sequence of more than one syllable The best-knonn language lacking an accentual organization of syllables is French

Accent sequences frequently serve to integrate words; a word that lacks an independent accent pattern is either proclitic (if it depends upon the following word) or enclitic (if it depends upon the preceding word). Similar features, especially pitch (usually called intonation) and the distinctive manner of cutting off the voice (usually called terminal contour), are used to organize longer sequences — phrases and sentences. Spanish has an array somewhat similar to the four distinctive pitch levels and three types of cut-off of English Japanese seems to have intonation patterns, but no terminal contours; Ojibwa has contours, but no intonations of the sort English has. No known language may be said to lack intonations and contours entirely. French employs stress. in addition to pitch, in contour patterns (as in *áttention!*).

Languages show great variety in their exploitation and distribution of accents. Thus, while English has only one major stress in a polysyllabic word, many languages permit more than one. In English, stresses occur only with vowels; in Czech, they occur also with the semiconsonants *r* and *l;* in South African Bushman, tones occur with vowels and often with nasals; in the Wahgi language of New Guinea, the stress-pitch accent occurs with all vowels and most consonants. Within the syllable there is also endless variety; though one may hear the accent as acoustically overlying the whole syllable, in some languages it has a structural position within the syllable. Stress in English and Spanish and tone in Japanese, Navaho and Cuicateco (Oaxaca, Mex.) cannot be assigned a sequential position. But the tones of Chinese and Lushai (India) seem to belong to the end of the syllable; those of Trique (Oaxaca) to the middle; those of South African Hottentot to the beginning; while the mobile stress of Lithuanian and Karok (California) and the pitch of Lettish may occur at distinctively different points along the syllable. The greatest number of level tones (five) yet described is found in Trique. On the other hand, Mazateco (Oaxaca) has four, but permits combinations of up to three within a single syllable: as a result, the sequence of tones carries so much of the distinctive features of words that Mazatecs can whistle complicated messages over distance. In many languages the simple accents are not level. but have a broken or gliding contour; in Burmese tones, pitch is associated with glottalization.

Accents are usually more difficult to reconstruct than other phonemes of dead or prehistoric languages. They are rarely recorded in writing systems. and they usually change in the course of time, making recovery difficult. Weakly stressed syllables are frequently lost in time, as from Latin to French (*frigidum* to *froid*). Other sounds may also change quite differently depending on their accentual environment.

The ancient Greek grammarians devised marks to indicate the accents of their language. the primary feature being pitch. The Greek term for accent mas *prosodia* (literally translated by the Romans as *accentus*), which later came to be used to refer to metrical quantity (whence the English "prosody"). The ancient Hindus marked the accents in their Vedic hymns. and this system became known to Western scholars when they first learned Sanskrit. The modern scientific tradition represents a confluence of these two ancient traditions.

The diacritical marks, misleadingly called acute (´), grave (`) and circumflex (ˆ, ˜ and ¨) accents, used to distinguish different vowels in written European languages are not subsumed under any of the above senses.

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ACCEPTANCE, in law. an act of consent or approval, having special significance in different situations. Thus, the term may be applied to the act of a person in signing his name (or his name with the word "accepted") across the face of a bill of exchange or draft addressed to him. He thereby obligates himself, as acceptor, to pay the bill according to its tenor or, if. the acceptance is qualified, according to the terms of the acceptance. A bill accepted by a bank, typically in a letter-of-credit transaction, is called a "hanker's acceptance" and has the highest credit standing. (*See* COMMERCIAL PAPER.) Again, acceptance may refer to the act of a person in agreeing to the terms of an offer, thereby completing a contract with the offeror, as to perform services or to sell goods. The offeree. in so doing, makes himself liable to an action for damages in case of default, or, where the contract is for unique goods. to an action for specific performance. (*See* CONTRACT.) Acceptance may refer also to the act of a buyer in receiving goods delivered to him by the seller. Acceptance of the goods, although there is no written contract, will satisfy the Statute of Frauds. Acceptance of nonconforming goods, after inspection or a reasonahle opportunity to inspect, will bar a subsequent return or rejection of the goods; but, to encourage acceptance in such cases and thus promote the flow of goods in commerce, an action against the seller for damages will survive. *See* SALE OF GOODS. (R. T. S.)

ACCESSORY, a person who incurs criminal liability for participating in the commission of an offense by another. An accessory before the fact is a person who urges or advises the principal offender to commit the crime; he is classed as principal in the second degree if he is present when the offense is committed and aids or abets its commission. At common law the distinction between principals and accessories applied only to felonies. In cases of misdemeanour or treason all participants were punishable as principals. The accessory after the fact falls in an entirely separate category and refers to a person who harbours or conceals a felon with intent to prevent apprehension of the felon. See ABETTOR; CRIMINAL LAW. (F. A. A.)

ACCIDENCE: *see* GRAMMAR.

ACCIDENT (Latin *accidens,* "happening" or "occurring"), a term used in philosophy with various meanings according to the term with which it is specifically or by implication contrasted. The principal philosophical meanings, summarized in this article, are historically connected with one another; and one of them (see *Accident, Necessity and Design,* below) is in turn connected with the ordinary use of the term to designate an unforeseen and often disastrous event.

Accident and Substance. — Perhaps the oldest use of the term "accident" was by way of contrast with the term "substance" or "thing." "Substance" means the basic reality which has various qualities, stands in various relations, etc. These qualities, relations, etc., on the other hand, need a basis or support to qualify—they are "accidents," accessions to something that is there to bear them (substance). Among the schoolmen, accordingly, almost any quality was commonly called an accident; and this usage was fairly common even in the 17th century — "accident" and "substance" corresponding roughly to "quality" and "thing" respectively, as these terms are commonly used.

Accident and the Self-Existing. — In the strict sense of the term, as distinguished from its more usual meaning even among philosophers, the term "substance" means that which exists in itself and through itself; and when so interpreted its familiar contrast with "accident" naturally prompts the application of the term "accident" to anything that is dependent on some other thing. In this case, even what are commonly called "things" or "substances" will be classed among "accidents." Thus for Spinozism there is only one Substance, namely God, who alone is self-existing, while all finite things and even the so-called "infinite modes" (such as motion) are really "accidents," or dependent existents. Cartesianism, too, made this admission, or one very like it to all intents and purposes, but allowed the name "substance," in a qualified sense (that is, in the popular sense) to finite bodies and to souls

Real Accidents. — The antithesis between "accident" and self-existing "substance" clearly cuts across the distinction between "accident" in the sense of "quality," and "substance" in the sense of "thing." In considering the latter distinction, however, some of the schoolmen maintained that there are certain sense-qualities of things which are not dependent on the substances with which they are sometimes combined, but can exist by themselves, apart from such substances. These alleged independent or self-existing qualities they called "real accidents."

Accident and Essence. — The distinction between "substance" and "accident" naturally led people to regard an "accident" as something less important than substance, as something not essential to substance; and so the term "accident" was contrasted with whatever is not really essential to anything. Thus in logic, for instance, the so-called fallacy of accident is the erroneous assumption that a claim to know anything or anybody implies a knowledge even of all that is nonessential in relation to it or him. Similarly, in the doctrine of the predicables (*q.v.*), as commonly expounded in books on logic, the predicable "accident" is contrasted with the other four predicahles in the sense that any predicate asserted of a subject but not essential to it is called an "accident" of it, whereas any predicate essential to the subject of which it is affirmed belongs to one or other of the remaining predicables.

Accident, Necessity and Design. — The kinship between what is "essential" and what is "necessary" has prompted the common use of "accident" for what is otherwise called a chance occurrence. Likewise, the term "accident" has come to be applied in law to any occurrence or result that could not have been foreseen by the agent (because not necessarily involved in his action), or to a result not designed (and, therefore, presumably not foreseen) or, lastly, to anything unexpected.

"Essential" and "Accidental" Accidents.--One curious consequence of the multiplicity of meanings of "accident" is that by using the noun in the sense of "quality" and the adjective in the sense of "not essential," the schoolmen came to distinguish between "essential" accidents and "accidental" accidents.

ACCIDENTALS, in music, are signs signifying that the notes to which they are attached have to be raised, lowered or restored to their original pitch, as the case may be. Thus a sharp (♯) raises a note a semitone; a flat (♭) lowers it a semitone; while a natural (♮) restores it to its former status. Each sign may also be doubled, though in the case of the double sharp, signifying the raising of the note by two semitones, the sign × is used instead of ♯♯; ♭♭ indicates a double flat, signifying the lowering of the note by two semitones. A single natural is sufficient to cancel a preceding double sharp or double flat. Accidentals placed before a note normally affect that note only during the bar in which they occur. In some modern compositions, however, where the harmony is complex, accidentals refer only to the immediate notes with which they are associated. In such cases the composer gives a direction to this effect. Sharps and flats placed at the beginning of a staff denote the tonality of the music and are not classed as accidental~.

See also MUSICAL NOTATION.

ACCIDENT INSURANCE: *see* CASUALTY INSURANCE.

ACCIDENTS: *see* DANGEROUS OLCUPATIONS; INDUSTRIAL MEDICINE; DROWNING AND LIFESAVING; and INDUSTRIAL ACCIDENTS.

ACCIUS (ATTIUS), **LUCIUS** (*170–c.* 85 B.C.), greatest and most popular of the Roman tragic poets, came of freedman stock in Umbria. His plays, of which more than *30* titles and about 700 lines have survived, were mostly free translations from the Greek, ranging over the whole field of Greek tragedy from Aeschylus (*Myrmidones, Prometheus*) to Hellenistic drama (*Hellenes, Stasiastae*); some plays were taken from Sophocles (*Antigone?, Athamas, Tereus*), a great many from Euripides (*Alcestis, Bacchae, Phoenissae, Telephus*); others again apparently combined two originals (*Armorum iudicium,* from Aeschylus' *Hoplon krisis* and Sophocles' *Ajax*). But he also composed two plays, *Decius* and *Brutus,* on Roman subjects. Accius' passion, loftiness of diction and splendid use of rhetoric were admired by Roman critics and

are discernible in the fragments. His plays were performed until the end of the republic. He also wrote love poetry and verse treatises in various metres on the history of Greek and Latin poetry and on agriculture.

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ACCLIMATIZATION, in biology, originally was taken to mean only the ability of human beings or animals or plants to accustom themselves within the span of a lifetime to new and strange climatic conditions. (Adjustments due to genetic changes are called adaptations, as also are the rapid adjustments constantly being made by the sense organs; see below.)

A man moves to a hot climate and is uncomfortable there; but after a time he is better able to withstand the heat. Aside from temperature. however, there are other aspects of climate. A man or an animal may become adjusted to living at altitudes higher than those to which he was originally accustomed. At ordinary mountain altitudes this does not involve much of an adjustment to change in atmospheric pressure, for mountain climbers suffer more from lack of oxygen than from change in pressure (see HYPOXIA). However, at really high altitudes, such as airplane pilots may be exposed to, the low atmospheric pressure becomes a factor of primary importance. In changing to a new environment a man may meet new conditions of temperature or pressure, and in addition he may have to contend with different chemical surroundings. On high mountains he encounters relatively low concentrations of oxygen; in crowded cities he may become exposed to relatively high concentrations of carbon dioxide or even carbon monoxide; and in various areas he may be exposed to conditions in which the water content of the atmosphere is extremely high or extremely low. Thus. in the case of man and higher animals, the concept of acclimatization includes the phenomena of increased toleration of high or low temperature, of altered pressure and of changes in the chemical environment.

Lower animals and plants are exposed to an environment very different from the environment of a terrestrial mammal. Fishes may live at or near the surface of the ocean or at great depths; in fresh water or in salt water. The ability of an aquatic animal to change from one type of environment to another is the same sort of a phenomenon as the ability of a terrestrial animal to change from one climate to another. Numerous investigators have tried to transfer fish: clams, crabs, etc.. from salt water to fresh, or from fresh water to salt, and they have examined the conditions which favour the success of such transfers. In order to include, therefore, all types of organisms and all types of environments a broader definition of acclimatization is required: the process in which an organism or a part of an organism becomes accustomed or hardened to an environment which is normally unsuitable for it or deadly for it. By and large, acclimatization is a relatively slow process. The term, therefore, should not be taken to include relatively rapid adjustments such as our sense organs are constantly making—the type of adjustment commonly referred to by the physiologist as adaptation. Thus after a time we fail to hear the ticking of a clock; to detect an obnoxious odour; to squint in bright light; etc.

On the other hand, when an adjustment to an unfavourable environment requires several generations, this is scarcely acclimatization in the strict sense (although often in the past it has been so considered). If a species of animal or plant is moved to an unfavourable environment, the individuals of the species may, after a number of generations, be better able to withstand the unfavourable conditions than were the animals and plants that first moved into the new environment. This may be due not so much to any change or acclimatization during the lifetime of the original animals or plants, or their descendants, but rather to changes or mutations from generation to generation. Such mutations are now known to be of relatively frequent occurrence (see HEREDITY; GENE). The mutations that are more apt to prosper in a given environment tend to survive (as a result of natural selection); the unfavourable mutations tend to die off. Thus, wheat plants that are moved to an excessively cold climate may, during successive generations, produce mutations that are better able to withstand the cold; these mutants, then. would tend to survive and would pass on to their progeny the same hardiness. This type of natural selection is well known, and it can be hastened by artificial selection on the part of the agriculturist. The end result is to produce new strains or races which are better able to withstand a particular environment than did the original species. (See ADAPTATION, BIOLOGICAL.)

The change in a species is a very different process from the acclimatization change which occurs during the life of an individual. If one considers the behaviour of a species for a number of generations, it is hard to distinguish between the changes produced as a result of mutation followed by natural selection and the changes produced as a result of true acclimatization.

The fundamental fact about acclimatization is that all animals and plants have some capacity to adjust themselves to changes in their environment. This is one of the most remarkable characteristics of living organisms, a characteristic for which it is extremely difficult to find explanations. Before entering into a more detailed treatment of the various facts and theories concerning the different types of acclimatization, a brief discussion of the ability of various animals and plants to change their habitat from one region of the earth's surface to another is presented. This subject has been studied primarily from the viewpoint of human welfare and human economy.

Acclimatization of Various Species, Including Man.— Early writers on biology and natural history, as well as early travelers and explorers, were interested in the possibility of importing animals and plants from one country to another. Tobacco. originally found in America, was introduced into Turkey and other countries. Cotton likewise was transplanted. Rubber and quinine. originally produced in South America. became staple crops of the East Indies. Flowers and shade trees found their way from one country to another. So, too, horses were imported into the Americas, and various other domestic animals were introduced into different parts of the world. Sometimes noxious insects or other types of pests find their way into countries originally free of them. The entrance of such undesirable organisms is often a matter of great economic importance.

An animal or a plant from a strange country may be successfully introduced into the homeland, or it may not be able to live there. Usually the important variable is temperature. Some animals seem to be able to exist anywhere. As Charles Darwin pointed out in his *Origin* of Species, rats and mice can live in very cold climates as well as in the tropics. Some other animals are very sensitive to changes of temperature. Possibly, in part at least, the ability of rats and mice to live in different climates is due to their nocturnal habits. Both rats and mice are sensitive to high temperatures and are much more readily killed by heat than are cats and cows. for example. It is doubtful whether rats or mice could withstand any lengthy exposure to the rays of the tropical sun.

Years ago, as new countries were discovered and developed, societies were founded to promote the exchange of species of animals and plants from one part of the world to another. The most famous of these societies was the Société Nationale d'Acclimatation in Paris.

The introduction of a species is not always accompanied with difficulty. Some species thrive away from their natural habitat. often better than in their homeland. In such instances there is no need for the species to become accustomed to the new habitat, and in reality acclimatization does not occur. The organism becomes naturalized, but not acclimatized (see NATURALIZATION OF PLANTS AND ANIMALS).

The question of human acclimatization has interested historians, geographers, sociologists and medical men. The early Greek writers wondered why white men did not successfully colonize tropical countries The difficulties of white settlers in the tropics are manifold, and the problems are extremely complex. It is hard to distinguish between the direct adverse effects of climate and the deterioration and death caused by the many types of tropical

disease. In addition, the white man in the tropics often has had to face the competition of coloured races perhaps more capable of withstanding the heat. Then too the conditions of life often are strange and difficult and this may be a factor in the causation of what has been called "tropical neurasthenia," a neuropsychological affliction.

In the 20th century, when sanitary and health conditions have been improved, as in Panamá and in northeastern Australia (eastern Queensland), acclimatization of white settlers is favoured. Some medical authorities have urged that if tropical disease could be prevented, white men in the tropics would prosper. Others have insisted that, quite apart from disease, the climate itself is harmful. Women are said to be paler in the tropics. In very hot regions, according to some observers, the effects of old age appear earlier. Some physicians claim that old-age vision (presbyopia), which in temperate climates usually is not noticeable until a man reaches the age of about 45, may become evident in Europeans in the tropics about 10 years earlier. Hot climates have been blamed also for premature loss of memory.

Surprisingly enough, little attempt has been made to study conditions that favour successful existence in hot countries. Of course, air conditioning can change the climate within the home, which, along with the introduction of modern methods of transportation, eventually may effect a partial solution of the practical problem of life in the tropics; however, knowledge of the physiological aspects, is meagre. Authorities agree that excessive use of alcohol is fatal to anyone who attempts to live under tropic conditions. Some Australian experts believe that manual labour is helpful to the health of dnellers in the tropics.

Because salt is lost through the sweat, men in the tropics, as well as workers in industries in which exposure to high temperatures is common, are urged to eat salt occasionally. Presumably there are benefits from this practice, but they are not great.

Diet may be an important factor in determining human resistance to heat. It is generally agreed that in warm climates there is an unconscious tendency for people to choose diets lower in protein and fat and higher in carbohydrates. Such a practice is perhaps beneficial and there may be a theoretical reason why it should be (see below).

As is well known, men can to some extent become acclimatized to life at high mountain altitudes. This acclimatization is primarily an adjustment to the low oxygen concentration of the air over the mountains. When a man first ascends a high mountain, his heart beats faster and he becomes breathless; he may also be nauseated and vomit, his head may ache and his nose may bleed. After a short time these symptoms of mountain sickness tend to disappear. The physiological adjustment is somewhat complex, but for one thing there is an increase in the ventilation of the lungs so that more air passes through them in any given interval of time. Also the hemoglobin of the blood acquires a greater affinity for oxygen than it normally possesses. In addition the actual concentration of hemoglobin in the blood increases.

Heat.—In general, animals show a very definite ability to become acclimatized to temperatures somewhat above those they can normally withstand. For example, the common American black bass (Micropterus salrnoides) if kept in warm water at a temperature of 86° F. for four days becomes more resistant to heat. Normally 50% of these fish die when exposed for an hour to a temperature of 93° F., whereas those conditioned in the warm water for four days reached their death point at a temperature of 100" F. Thus their tolerance to heat had been raised approximately 7°. On the other hand, when the fish were kept for 16 days at a temperature of 50° F., half of them died when exposed to a temperature of 86° F. for an hour. Other fishes show a similar behaviour. Toad tadpoles raised in the warmth were found to be able to stand temperatures about 6° higher than those raised in colder water.

Lower animals show a somewhat similar behaviour. For example, protozoa can be acclimatized so that they will withstand temperatures 4°–5° higher than those temperatures which normallv kill them.

In the summer, as might be expected, animals are commonly better able to resist heat than in winter. In the case of the common sand or mole crab (Emerita *talpoida*) of the Massachusetts coast the lethal heat temperature is 18° higher in summer than it is in the winter.

The mechanism of heat acclimatization is uncertain. In man changes in the sweating mechanism or in the blood circulation may play a part. Only a few mammals sweat, however, and yet acclimatization to heat is very generally exhibited by all sorts of organisms, even by those which completely lack blood. As a matter of fact, essentially all living cells are heat sensitive, and the temperatures which kill them often are only a few degrees above those at which they are accustomed to living. In lower animals heat death is simply due to the death of the constituent cells. In higher animals some cells appear to be more sensitive than others, and the death or injury of these cells apparently produces toxic substances which injure and eventually kill the animal as a whole.

In general those organisms which are killed at the higher temperatures have more solid fats; that is fats with higher melting points. This is a broad truth which holds both for animals and plants: fishes, which die at relatively low temperatures, have fats fluid at ordinary temperatures; whereas the warm-blooded mammals and birds have solid fats. Similarly plants which grow in the tropics seem generally to have more solid fats than those which grow in temperate climates. Various experimenters have shown that when animals are reared at higher temperatures. their fats tend to become more solid. Such a change in the melting point of the fats may be a factor in the acclimatization of animals and plants to heat.

Further, recent nutritional studies have shown that if animals eat sugar, the fat produced within the body from this sugar has a high melting point. The fact that other animals (namely, rats) with fats of higher melting point are better able to survive higher temperatures perhaps indicates why men in hot countries seem unconsciously to prefer a diet relatively rich in carbohydrates.

Cold.—There have been relatively few studies on the ability of animals to become acclimatized to cold. Fishes accustomed to warm water are unable to withstand sudden transfer to cold water. At Naples, the eggs of the sea urchin (Paracentrotus *lividus*) cannot develop at temperatures below 61° F. in summer, but in the wintertime they can develop at temperatures as low as 47° F.

The ability of plants to become acclimatized to the cold is a matter of great practical importance. Tropical plants are killed at temperatures above freezing. In cold countries plants frequently suffer injury from frost. As a result of breeding experiments and as a result also of chance mutations, cold-resistant varieties of wheat and other crop plants have been obtained. These varieties have made farming possible in regions where it might otherwise have been impractical. But even for any given variety of a plant, some increase in so-called cold hardiness is possible. For when plants are grown at lower temperatures they are better able to withstand frost.

When plants are exposed to the cold, there may be an increase in the amount of sugar or salt contained in the plant cells, and such increases would tend to prevent freezing. Possibly also, in hardy plants, water is prevented from freezing by being bound chemically in such a way that it does not act as ordinary water. Some workers believe that cold hardiness primarily is caused by an increase in the amount of this "bound water." This explanation, however, does not seem to fit all cases. A protein jelly, such as a gelatin gel, does not freeze so readily as a fluid protein solution. It is possible, therefore, that the state of fluidity of the vital protoplasm may be a factor in determining cold hardiness.

Marine and Fresh-Water Acclimatization.—Ordinarily animals which live in the ocean die rather rapidly if they are placed in fresh water; also fresh-water animals die in sea water. This is not always true, however, for the eel and the salmon can pass from sea water to fresh water and back again without injury.

Fresh-water animals placed in water containing a large amount of salt tend to lose water from their cells (and in the case of simpler animals, there is a considerable loss of water); on the other hand, marine animals placed in fresh water tend to absorb water into their cells. The process producing this inflow and

outflow of water is called osmosis, a general phenomenon operating throughout the animal and plant kingdoms.

The cells of all animals are in equilibrium with the solutions in mhich they are bathed. If these solutions become more dilute, the cells increase in volume; if on the other hand, the concentration of the solutions is increased, the cells lose water and shrink. Many higher animals are enclosed in stiff integuments which prevent the free passage of water to the constituent cells, and such animals are less sensitive to changes in the salt content of the outer medium; although. of course, within the bodies of the animals the cells are in equilibrium with the blood or other fluids of the animal.

Sea nater contains many types of salts, but by far the most abundant of these is ordinary table salt (sodium chloride). The concentration of salt in sea water is approximately the same as that of a 3% solution of table salt. If fresh-water animals, normally incapable of living in sea water, are placed in a very dilute salt solution to which salt is gradually added over a period of meeks or even months, it is in some instances possible to acclimatize the animals so that they can live in solutions as salty as or even saltier than sea water. Also, with the gradual addition of fresh water to the sea water in which marine forms are living, marine animals can be made to live in solutions whose iack of salt ordinariiy mould kill them rapidly.

Different types of animals vary widely in their capacity to become acclimatized; all sorts of adjustments are involved. Presumably with an increase in salt content of the surrounding medium, both the cells and the body fluids of the animals become richer in salt. An important factor is the ability of an animal to excrete salt. Ordinary fishes are able to excrete salt through their gills; this aids them in their adjustment to the salt water of their surroundings. Marine birds are able to excrete salt through an enlarged nasal gland.

On the other hand. the excretion of water by animals enables them to get rid of excess water taken in through the skin. Thus a frog immersed in water is continually taking up water through the skin and excreting it by way of the kidneys. Obviously, excretory processes may play an important part in the ability of animals to accustom themselves to changes in the salt content of their watery environment.

Chemical Acclimatization. — All sorts of organisms show some power of accustoming themselves to a wide variety of poisons. Bacteria and protozoa may acquire an increased resistance to such substances as mercuric chloride, quinine, etc. Such acclimatization becomes a factor in the treatment of disease, for protozoan and bacterial parasites that are normally killed by a certain concentration of a drug may after a time become resistant.

Bacteria and protozoa reproduce very rapidly — on the order of once every 20 or 30 minutes — and accordingly, in studies of acclimatization in these lower organisms, the acclimatized organisms are descendants of the original organisms. Consequently, new types of organisms may arise in successive generations as a result of mutation. Some of these newly mutated types may be more resistant than the original forms and would tend to be selected out, that is, they would show a greater tendency for survival.

In higher animals true acclimatization to chemicals undoubtedly occurs. Mice and rabbits can become somewhat acclimatized to the presence of carbon monoxide in the atmosphere. Man can train himself to eat increasing amounts of certain poisons and thereby acquire a tolerance for these poisons. Various types of explanation are possible. One theory is that when a tolerance to arsenic is acquired, there is less absorption of the poison from the intestine. Earlier, tolerance to alcohol was thought to involve a decreased absorption, an increased or more rapid excretion, a decrease in the amount of alcohol which reaches the brain or an increase in the rate at which alcohol is chemically transformed within the body. Modern studies, however, tend to disprove all these possibilities; it seems that human tolerance for alcohol is primarily due to an acclimatization of the cells of the central nervous system.

Many living organisms produce poisonous substances. Thus toadstools are notoriously poisonous and so too are many higher plants, as well as scorpions, spiders, snakes, etc. In general the organism producing the poison is immune to its effects. A man can be made tolerant, that is, made immune, to a certain type of snake poison. and similar immunity may be acquired for various bacterial poisons. The attempt to understand this type of immunity is of such importance to bacteriology and medicine that an entire science. immunology, has been built around it.

One of the most interesting types of chemical acclimatization is that shown by bacteria and yeasts toward food substances in their environment. Yeasts, which commonly live by fermenting sugars, normally utilize certain types and not others. If, however, a yeast colony is grown in a medium containing an unusual type of sugar, one which it does not have the power to attack, it may after a time acquire this power.

In animals generally, cells and tissues may acquire an increasing ability to cope with substances originally more or less alien to them.

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ACCOMPANIMENT, a musical term signifying an auxiliary part or parts of a composition designed to support the principal part or to throw it into relief. In secular medieval music and early folk music, instrumental accompaniments for singers consisted of unison or octave reduplications, novel rhythmic features or a primitive type of harmony in the form of a drone or sustained notes on wind or string instruments. In the 16th century, solo songs were sung with simple harmonic or contrapuntal lute accompaniments, notably those of John Dowland and the French airs *de cour*. With the introduction of the thorough bass at the beginning of the 17th century the art was gradually developed of harmonic accompaniments. improvised at the harpsichord or organ and based on chords which the composer indicated by figures. By the 18th century these improvised accompaniments, designed to support either a soloist as in the sonatas and solo cantatas of J. S. Bach, or an instrumental ensemble as in the operas of Alessandro Scarlatti, demanded from the performer a high degree of ornamental and contrapuntal invention. The accompaniment thus assumed a role as important as that of the soloist. *(See* also THOROUGH BASS.)

The term obbligato accompaniment was applied to this form, as opposed to ad libitum accompaniment, a term used for the optional reduplication of a part or unessential ornamentation performed on another instrument. Obbligato accompaniments were sometimes written out, among them one originally improvised by Bach for a movement of his Sonata in B minor for flute and harpsichord. In the second half of the 18th century the obbligato accompaniment assumed a primary role, the part of the solo instrument being reduced to an ad libitum accompaniment. Sonatas for harpsichord or piano with violin or flute accompaniment were written by Joseph Mondonville, and Mozart followed the example of Johann Schobert in writing four sonatas for harpsichord accompanied by the violin.

The influence of the obbligato style in the 19th century is suggested in Beethoven's statement, "I came into the world with obbligato accompaniment." It persisted in both the solo and the concerted works of the romantic composers where accompaniments became even more elaborate and expressive The greater expressive resources of the piano, as opposed to the harpsichord, allowed the accompaniments of Schubert to illustrate pictorial or psychological aspects of the texts of his *Lieder*. His example was followed in the *Lieder* of Schumann, Brahms and Hugo Wolf. Piano accompaniments in works for string or wind instruments acquired the status of a concerted part. Orchestral accompaniment, which in the 18th century had hardly exceeded chamber-music proportions, was greatly developed in the romantic concerto and in songs or song cycles with orchestra by numerous composers from Berlioz to Alban Berg and Benjamin Britten.

The art of the piano accompanist flourished chiefly in response to the demands in the 19th century of the German *Lied* and the

French *mélodie*. Qualities of poetic and musical insight, and also of ensemble playing, distinguish the piano accompanist's art which resembles the art of performance in chamber music. Accompanists such as Gerald Moore and Conraed van Bos developed the art by their sensitive attitude to the soloist and by their power to interpret the composer's intention. Both Moore and van Bos have written valuable books on the art of the accompanist. (E. LR.)

ACCOMPLICE, a person who is associated with another in criminal activity. The category includes, but is not limited to, the accessory (*q.v.*). Some U.S. states provide by statute that testimony of accomplices is competent only when corroborated by other evidence. Elsewhere the jury is ordinarily cautioned as to the possible unreliability of testimony by accomplices. See CRIMINAL LAW. (F. A. A.)

ACCORAMBONI, VITTORIA (1557–1585), the Italian lady whose story forms the basis of John Webster's tragedy The White **Devil,** was born in Gubbio, near Perugia, on Feb. 15, 1557. In 1573 she was married to Francesco Peretti, whose uncle Cardinal Montalto (Felice Peretti) was regarded as likely to become pope. In Rome she found many admirers, among them Paolo Giordano Orsini, duca di Bracciano. Her brother Marcello, wishing to see her married to Bracciano, had Peretti murdered (1581). Bracciano, who was already believed to have murdered his first wife, Isabella de' Medici, was suspected of complicity in this murder also! but proceeded to marry Vittoria. Early attempts by the Peretti family to have the marriage annulled had no result except that Vittoria was imprisoned for a short time. In 1585, however, Montalto was elected pope as Sixtus V, and the couple. fearing that he would avenge his nephew's death, fled to Salo in, Venetian territory, where Bracciano died (Nov. 1585). Vittoria then retired to Padua. There she was followed by Lodovico Orsini—a remote cousin of Bracciano's—who hated her personally and resented her marriage as degrading to the Orsini family. On Dec. 22, 1585, he had her murdered. He and his accomplices were executed by order of the Venetian republic. Besides Webster's play, Vittoria was the subject of Ludwig Tieck's novel, Vittoria *Accorambona* (1840).

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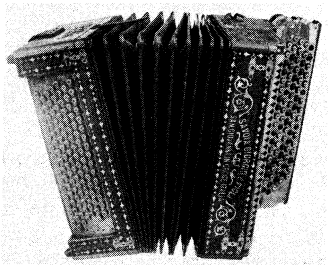
ACCORDION, a musical instrument of the free reed class. The name first appears in the 1829 patent of C. Demian, Vienna, though an earlier model was patented by Friedrich Buschmann in Berlin in 1822. A free reed is a metal tongue screwed or riveted over a slot accurately cut in a metal frame. The pitch of a reed depends upon the length and thickness of the tongue, which can be tuned by filing near the free end to raise the pitch or near the fixed end to lower it. Each tongue is "sprung up" above its frame and vibrates when air is made to flow around the reed from this upper side; an air flow in the opposite direction does not cause the tongue to vibrate.

An accordion consists of a bellows fastened between two oblong wooden structures that carry the reeds, to which wind is admitted selectively through pallet valves controlled from a keyboard or set of finger buttons, each key or button bringing into action a pair of reeds, one of which is mounted to sound on the "press" of the bellows, the other to sound on the "draw." In some forms of accordion, including the early designs, the two reeds of a pair sound two adjacent notes of the scale, so that a button will give, for instance: G on the press, and A on the draw ("single action"). By this arrangement ten buttons suffice for a diatonic compass of over two octaves, though at the cost of rendering each note available with a bellows movement in one direction only. For the left hand there are, typically, two keys or "basses" to provide bass notes and major chords respectively, sounding the tonic on the press and the dominant on the draw, in one tonality only. This single-action accordion has been developed, chiefly in Austria and Switzerland, by adding a second row of buttons giving a scale of F (the first-row scale being C). so arranged that almost every note of the diatonic series becomes available with a C-row button on the press and an F-row button on the draw, or vice versa. Semitones are provided by additional rows and the number of basses is increased.

In the piano accordion, with piano-style keyboard for the right hand, introduced in the 1850s and later perfected in Italy by Dallapè, the two reeds of each pair are tuned to the same note, thus making every note (also every bass) available from one key with both directions of movement of the bellows ("double action"). Among other improvements, steel reeds, instead of brass, give a steadier pitch to the notes. Couplers or "registers." developed in the 1930s, bring into action extra sets of reeds. one set pitched an octave below the main set and another off-tuned from the main set to give a tremulant through "beating." Other registers may include a high-octave set and a second tremulant. Each set may be used alone or in combination with others, by means of switches placed above the keyboard and identified by symbols or descriptive terms. The left-hand provision is also greatly extended, with up to 120 basses actuated by six rows of buttons. Two rows give bass notes arranged in cyclic order of tonalities (D, G, C, F, etc.), one row being offset against the other at the interval of a major third, to facilitate melodic passages for the left hand. The other rows give three-note chords, respectively major and minor triads and dominant and diminished sevenths. There are up to five registers for the basses, causing each bass note to sound over as many as five octaves if desired and each chord to sound in three.



BY COURTESY OF THE PHILIP LESLY CO

ITALIAN ACCORDION. 19TH CENTURY

A variant of the accordion is the bandoneon, a double-action instrument with square shape and finger buttons, invented by Band of Crefeld, Ger., and the leading solo instrument in modern Argentine tango orchestras. For precursors of the free-reed instruments, see the article HARMONIUM, and for other types see CONCERTINA; HARMONICA. (A. C. BA.)

ACCORSO (ACCURSIUS), **MARIANGELO** (c. 1480–1546), Italian poet and critic, known for his satirical dialogues and his edition of the letters of the Roman statesman Cassiodorus, was born at Xquila, *c.* 1480. He became a favourite at the court of Charles V. by whom he was sent on numerous foreign missions. He is considered the first scholar to have investigated Roman epigraphs.

Though an accomplished linguist and, in his day, an acknowledged judge of Greek and Latin poetry, Accorso was himself not more than an academic poet.

He died at Aquila in 1546.

ACCOUNTING, a broad term that denotes certain theories, behavioural assumptions, measurement rules and procedures for collecting and reporting useful information concerning the activities and objectives of an organization. In less general terms, accounting consists of procedures for recording, classifying and interpreting selected experiences of an enterprise to promote effective administration.

It is now generally agreed that accounting and similar information-control systems must serve the needs of those who direct the organization. This approach requires that accountants know who is to use the information and must understand the objectives involved and the nature of the decisions to be made. It also requires that accountants select a consistent set of rules and conventions to accumulate and report information in a manner designed to encourage desirable performance. Accounting is used to denote the occupation of those who devote themselves to these activities. The term bookkeeping (*q.v.*) is used to indicate the gathering and classifying of data according to established rules regardless of whether the work is done by individuals, machines or electronic devices.

Accounting Functions.— The primary function of accounting is to help society administer its financial affairs. Specialized combinations from the field of accounting often are found in such related fields as engineering and operations research, but the fol-

lowing functions are performed primarily by accountants: (1) Determining acceptable cost and revenue standards by detecting variations between actual and desirable performance and by determining the causes of the variations. Flexible budgets and other forms of performance budgeting are expressions of this function. (2) Measuring the progress of an enterprise in terms of income or profit. Such measurements help channel future investment and act as yardsticks for evaluating the enterprise's management. (3) Helping to safeguard the properties of the organization by employing suitable devices for discovering shortages and misuse of funds. Much of the network of red tape associated with accounting systems is devoted to this end. (4) Providing information to help solve problems of short-run liquidity and financial stability. (5) Determining the rights and relative positions of owners, creditors, income beneficiaries, remaindermen and other equity holders. including the interests of governmental taxing and regulating agencies.

Reporting Viewpoint.— The impossibility of collecting all information about an enterprise that conceivably might be useful to someone means that accountants must limit their reporting to data that are important and are clearly needed. Many events in the history of an organization may be neglected, and data on other aspects may be required only intermittently for specialized nonrecurring decisions. Accountants must possess the ability to furnish such information through supplementary reports that do not interfere with the routine periodic reports.

One of the first requirements of an information-reporting system is the definition of an entity—an area of interest. Selecting an entity requires the identification of the purposes of collecting and reporting information. A large organization may be divided into many responsibility centres for certain repofts; for other needs, the relevant entity may include many corporations, a sector of national activity or the entire world economy. Double-entry bookkeeping is sometimes based on the assumption that the entity and the proprietor are identical. Assets, liabilities, revenues, expenses and the interpretative viewpoint are defined and related to the position of the proprietor. The growth of large-scale enterprise has increased the number of identifiable interests (equities) in an organization, and reporting to the public now tends to take the form of stewardship reports that are focused on the entire organization as the basic entity and are geared to the needs of equity holders and other outside interests.

Internal reports to the various levels of management may be made frequently and may cover a wide range of topics. Reporting to outside interests is likely to include some combination of a financial status report in which assets are listed and classified in a meaningful fashion and are related periodically to equities, a profit-and-loss statement or a fund-flow report that summarizes changes in liquid resources.

System Requirements.— The design of an accounting system begins with a clear statement of the objectives of the enterprise, a description of the types of decisions required for guiding operations toward these objectives and an appraisal of the ability of individuals to adapt to new modes of reporting. An understanding of these features permits the designer to decide what information is necessary and to determine the form and content of the reports expected of the system. The data classification is set up to facilitate the preparation of the reports, and in turn the data-gathering system is designed to accumulate the required information with the least expenditure of enterprise resources. Inasmuch as accuracy and restraint of dishonesty are objectives, accountants have devoted considerable attention to devices of internal control so that the accuracy of the work of one employee will be checked by the work of another and so that misappropriation of assets will require collusion among two or more employees.

An important task for an accounting system often is to trace the cost of an operation, job, process or some other unit of activity with emphasis on accounting as an aid to internal managers. Special investigations and prospective cost studies improve decision-making in the fields of abandonment, expansion, shutdown, resource shifting, modernization and product planning. The field of cost accounting (*q.v.*) is concerned with aspiration levels and acceptable costs of attaining these levels. Variations between actual and programed costs are shown in the accounts or on supplementary records with the hope that administrative action will be improved. Costs and variations are isolated and correlated insofar as feasible with individual responsibility so that remedial action can be made effective.

Budgeting is now acknowledged to be a major part of accounting and to be a legitimate accounting activity. The chief accounting officer—the controller—has responsibility for co-ordinating estimates, accumulating and reporting actual performance, issuing reports of variations from budget and in some cases for enforcing the budget by encouraging laggards to better performance. Systems that combine budgetary and historical data for ready comparison are widely used.

Income Measurement Rules.—The usual concept of income is related to values that may be withdrawn without changing the prospects of an organization. Attempts have been made to make this concept operational by specifying rules for comparing discounted expectations at the beginning and end of each period, but accountants have been disturbed by the amplified effect of changes in optimism or pessimism in such a subjective measurement system.

Professional measurement conventions for income determination are more modest and consist of rules for recognizing and measuring new asset values (revenues). corresponding rules for recognizing and measuring declines in value (sacrifice) and further rules for matching (correlating) the results in periodic reports.

Asset value increases must meet certain standards of evidence. In rare cases (*e.g.*, installment method) only cash receipts are considered to be sufficient, but in most cases bona fide sale is acceptable evidence. In construction work the progress of physical construction may be used to support partial recognition. Many accountants build into their definition of income a further requirement that the net value increase be available in the form of additional working capital. Tax assessments on income and the historical association of income with dividends or other withdrawals have tended to focus attention on the liquidity aspects of enterprise operation. Even though value may be added when a favourable contract is procured, accountants will not report income at this stage. They may, however, insist on some form of disclosure.

The second aspect of the income measuring process concerns the measurement of effortexerted (capital consumed) in terms of costs expired. The profession has favoured the recording of explicit historical costs and a definition of income that calls for deducting from revenues sacrifice in terms of historical costs. Normally at the time of asset acquisition discounted service expectations are at least as great as the acquisition price of the productive agent. Actual services may yield discounted values far above or below cost. Depreciation and similar amortization problems are reduced to rules for spreading cost in proportion to services given. Inventory valuation becomes a process for assigning cost of goods available for resale to current and to future periods in proportion to similar estimates of benefit.

In times of changing price levels, revenues tend to adjust faster than costs with the result that costs of different vintages are matched with revenues. The unit for measuring cost has also changed and service estimates may thus be affected. Some accountants feel that current replacement costs best measure the sacrifice in getting revenue. Last in. first out (lifo) advocates are willing to match latest actual costs with revenue but as a group they prefer to measure capital consumption in terms of replacement cost at the time of sale. The implied definition of income is that the deductions from revenue should be sufficient to keep the physical assets intact. Other accountants feel that historical cost should be preserved by applying a general price index and converting the original costs and equities into current monetary units. The usual benefit (service) rule is applied to the restated and modified historical costs. Depreciation on replacement cost implies that income emerges only after provision for keeping physical assets intact and is therefore related to last in, first out.

Measuring income for short intervals is clearly subject to grave hazards. Cost expiration is difficult because many capital assets

yield benefits over many accounting periods, and the critical tests for revenue recognition often are met in an irregular fashion. Accounting and some taxing authorities have recognized the difficulties of short-period profit measurement and permitted limited application of annual operating losses to past and future gains—a type of averaging. Obviously measuring and reporting rules for a concern that is presumed to be continuing are widely different from those appropriate for a liquidating enterprise. The going-concern convention hardly qualifies as a fundamental principle of accounting, but one of the first tasks of an accountant is to determine whether the measuring conventions for a going concern are or are not appropriate in the particular case.

A common misconception is that the grand total of all assets at current values should equal the value of the entire concern. Many specific assets may yield economic rents, and accountants traditionally do not consider all items of value (worker morale, for example) to be assets. The difference between the total of all recognized specific assets at current value and the value of the entire concern as a going business is normally taken to be goodwill (*q.v.*). Many have felt that accountants should value the entire business periodically and adjust the income and goodwill account to reflect this valuation, but accountants have preferred to let prospective investors make their own enterprise valuations.

The Field **of** Public Accounting.— Public accountants carry on many activities, but their chief function is to render independent, unbiased, professional opinions regarding the accuracy of representations made by a firm's management. The primary responsibility of auditors is not to management officials but to outside groups who are interested in the affairs of the concern and need dependable information. The primary problem of auditing is to establish standards of evidence to support professional opinion. Sampling procedures are clearly necessary, and in recent years auditors have supplemented their intuitive feeling of adequacy with statistical help. Management self-interest may sometimes lead to pressures that influence reporting, and the rules of evidence for accounting and auditing work are developed with regard to the direction of such pressures.

Many accountants devote a greater proportion of their time to management services, and many firms employ specialists in operations research, information theory, engineering, labour relations and the behavioural sciences. Public accounting firms are developing in the direction of industrial accounting, and a hoped for by-product may be an increased acceptance of more responsibility to the public by controllers and other private accountants. They engage in many activities of a nonauditing nature. They may; ior example, design and install accounting and related information systems; develop cost and efficiency programs and standards; advise on income and other tax matters; serve trustees in liquidation or bankruptcy; prepare schedules for property and business appraisals for loan and insurance purposes; testify in disputes involving financial liability and relative status of equity holders; consult on matters of wage and management compensation and incentives; install budgetary controls over expenditures; advise on such management problems as capital budgeting, expansion, shutdown, abandonment and modernization.

A code of ethics and highly formalized rules of professional conduct have developed over the years. A distinctive characteristic is the concept of independence which arises primarily because of the auditing iunction and the necessity for expressing an opinion that managements' representations fairly present the financial position and the results of operations. Independence is, of course, a frame of mind, but it is presumed that independence does not exist if the auditor has a financial interest in the business or is a director, officer, underwriter or promoter of the business. Following are some of the important rules of proiessional conduct recommended by the American Institute of Certified Public Accountants: Opinions or representations in financial statements must contain no false or misleading statements and must be prepared in accordance with accepted accounting and auditing principles. Proiessional fees for service must not be coptingent upon the accountant's findings. There shall be no division of fees with nonprofessional persons. An accountant shall not violate any confidence between himself and his client. Only partners or employees may use the accountant's name in professional practice. Accountants shall express professional opinions only with respect to work performed by themselves, their employees or other professionally qualified accountants with whom they have co-operated. Practice of accounting in the corporate form of organization is prohibited. An accountant may not advertise his professional attainments or services, or solicit clients or encroach upon the practice of another accountant, but he may give service and advice to any client upon request.

Status and Organization of Public Accounting.— Public accounting in Great Britain is regulated by professional institutes, societies and associations. The Institute of Chartered Accountants of Scotland is the outgrowth of local units, the first of which was established by royal charter at Edinburgh in 1854. The Institute of Chartered Accountants in England and Wales was chartered in 1880. as a merger of several associations. the first of which was established in 1870. The Irish institute was chartered in 1888.

The Society of Incorporated Accountants in England was registered in 1885, under the Companies act of that year. The Association of Certified and Corporate Accountants was established in 1904 and later absorbed the membership of several organizations. By 1960 total membership of these British accounting organizations was more than 50,000.

Each group imposed an experience requirement, and membership in an institute required a period of articled clerkship under the direction of a chartered accountant. Admission requires written tests in accounting theory and practice, as well as in the related fields of law, economics and business administration. The practice of public accounting is not legally restricted in the British Isles, but certain responsibilities may be discharged only by members of an institute authorized by royal charter or of the societies and associations established in accordance with statutory regulations. The *Accountant,* weekly publication of the Institute of Chartered Accountants in England and Wales, was established in 1874.

The title of certified public accountant (C.P.A.) and requirements for the certificate were first created in the United States by the state legislature of New York in 1896. Pennsylvania followed in 1899, and by 1923 each state and the District of Columbia had enacted legislation by which a commission or an educational institution authorized use of the title C.P.A. on the basis of written examinations and acceptable education and work experience. College instruction may be substituted in some states for all or part of the practical experience requirements. In New York state a bachelor's degree became a requirement for eligibility to take the examination in 1938, and other states are rapidly increasing their requirements to that level.

Written examinations prepared by the American Institute of Certified Public Accountants are uniform in all states and consist of questions from the fields of accounting theory and practice. auditing and commercial law. All states have a C.P.A. society or its equivalent to co-ordinate activities and mork with the national organization. Most states grant certificates on a reciprocal basis to residents who have met similar educational and experience requirements. Some states also license public accountants who are not certified and permit them to carry on limited accounting and even auditing work.

The number of certified public accountants in the United States in 1960 was approximately 60,000 as compared mith 250 in 1900; 5,000 in 1920; 13,500 in 1930; 20,000 in 1940; and 38,000 in 1950.

The American Institute of Certified Public Accountants. whose name was changed from American Institute of Accountants in 1957, developed from the American Association of Public Accountants. organized in 1887, and several national groups. including the important American Society of Accountants, have been merged with the institute. The institute conducts a program of education, professional improvement and research on such subjects as accounting procedure, auditing methods, federal taxation, education, ethics and history. The institute publishes monographs, bulletins and books related to accounting, and in 1912 the *Journal*

of Accountancy, a monthly publication established in 1905, became the official periodical.

An institute of chartered accountants in Montreal received a royal charter in 1879, and later became a province-wide organization. Each Canadian province has an institute of chartered accountants with membership requirements patterned after those in Great Britain. Each provincial institute conducts an educational program as preparation for uniform examinations and membership. Their activities are co-ordinated through the Canadian Institute of Chartered Accountants, which publishes an official journal, The *Canadian* Chartered Accountant.

Societies of accountants in continental Europe have been established with much the same functions as those in Great Britain; *i.e.,* to examine and approve qualified persons for the duties of public accounting. There are records of an accounting association (Collegio dei Rnxonati) in Venice in 1581, and another was known to exist in Milan in 1739. Whether these groups were composed of independent accountants or accounting employees is not authoritatively established. The organization dates for associations of accountants in other countries are: France, 1881; Australia, 1885; Netherlands, 1895; Germany, 1896; Sweden, 1899; Belgium, 1903; Austria, 1904; Denmark, 1909; Finland, 1911; Switzerland, 1916; Japan. 1917. Auditing the accounts of private and communal enterprises in the Union of Soviet Socialist Republics became a governmental function in 1917, and accounting has received serious intellectual attention there and in other socialist states. Organizations of independent public accountants exist in some form in almost all countries that are beyond the embryonic stage of industrial development.

Government Control Through Accounting.— The possibilities for using accounting as an instrument of control increased with the rise of corporations and the separation of ownership and control. The English Companies act of 1844 permitted stock companies with limited liability of stockholders and provided that railroads should engage auditors to examine and certify to the accuracy and completeness of their financial reports. The Act of 1862 recommended that all corporations be audited by independent accountants. This feature became a legal requirement in England in 1900 with the auditors to be elected by the stockholders.

U.S. legislation affecting accounting practices began with the need for regulation of public utilities to determine fair and equitable rates. The fair-return-on-a-fair investment and similar guides lean heavily on accounting conventions for measurement of both return and investment. The Interstate Commerce commission, organized in 1887, supplemented its rules in 1906 by a uniform accounting system of reports. The Federal Power commission and many state commissions have stressed uniform accounting methods.

The income tax laws of 1909 and 1913, the formation of the federal reserve system in 1913, and the rapid growth of stock market transactions increased the need for uniform accounting reports and independent verification. Such requiremefits were established by the New York Stock exchange in 1932. and in 1934, by the newly formed Securities and Exchange commission. In the latter year, the national bankruptcy act prescribed uniform procedures for corporate reorganizations.

The Robinson-Patman act of 1936 defined price discrimination for purposes of the Sherman and Clayton acts in terms of price differentials not justified by differentials in cost. Numerous states developed legislation that prohibited sales at prices below cost to the seller. During and after World War II many contracts for government work and renegotiation procedures were framed in terms of allowable costs and made wide use of other accounting conventions. Needless to say, accounting devices for control are a necessity in socialist states and in the publicly controlled sectors of any economy.

Accounting Origins.— Records and reports have characterized the exchange of goods or services from earliest times. The levy and collection of taxes in the Babylonian empire required proof of individual obligations and payments. Clay tablets as well as stone and mood devices were used to record payments for services in temples. Tally systems that used notched and marked branches as evidence of indebtedness and repayment were used in the British Isles. The development of papyrus (paper) and the calamus (pen) in Egypt, about 400 B.C., facilitated the recording of information. Government records of the Roman republic in 200 B.C. classified cash receipts in such items as rent and interest, and expenses included wages, entertainment and sacrifices. Officials known as quaestors were designated to examine the accounts of provincial governors. The emperor Augustus is said to have established the first government budget in the year A.D. 5.

During medieval times, advances in accounting were made by government and church officials. Charlemagne in 800 ordered in the Capitulare de *Villis* that an annual inventory of property be taken with separate books for income and expense. Audits were made in England during the reign of Henry I (1100–35). The English pipe roll, 1131, was a record of taxes, debts and other liabilities due the crown.

Accounting for private business in terms of ventures was an outgrowth of Italian commerce during the 13th century. Loans to trading firms and the investment of money by partners led to the development of double-entry records and reports (see BOOKKEEPING) which reflected the interests of both creditors and investors and helped the merchants control their relations with customers and employees. The auditing function was originally performed during the industrial revolution by certain accountants who placed their knowledge and competence at the disposal of other organizations. through part-time or intermittent employment. They were known as public accountants and also were employed to install bookkeeping systems for new enterprises. Many public accountants also engaged in the practice of law or the teaching of commercial subjects, foreign languages or arithmetic. These combinations were especially common in Holland, France and Great Britain during the 15th and 16th centuries. A Scotsman, Alexander Herreot, served annual engagements for a Haddington cloth manufacturer from 1681 to 1703 and was well established by 1697 as a teacher of bookkeeping in Edinburgh.

The first person definitely presumed to have practiced public accounting on a full-time basis in western Europe was George A. Watson, who was born in 1645 in Edinburgh. An Edinburgh directory listed seven accountants in 1773, and there were six names in a Glasgow record of 1783. The 1809–11 edition of *Holden's* Triennial Directory indicated that 24 public accountants were practising in London in 1800. The government of Milan, in 1742, announced a scale of charges to be made by accountants for services to clients, which suggests the existence of a profession of public accounting at that time.

Charles Emmanuel III, of Italy, in 1790, recognized chartered accountants as the only persons qualified to discharge the duties of public accountants. Napoleon decreed in 1805 that an accountant wishing to practice independently in Italy must pass a required examination after serving with an approved accountant. Uruguay, in 1825, became the first country in the western hemisphere to regulate the practice of public accounting.

The importance of independent examination of business records was increased by international trade and by wars such as the American and French Revolutions, which caused many bankruptcies for British businessmen and increased the need to determine the losses and equities of the owners and creditors of the various firms. Early public accounting methods in the United States were greatly influenced by practices in England and Scotland, and British accountants were frequently engaged for services in the U.S. during the latter half of the 19th century by British investors in American land and industry.

Education and Training.— The complexity of modern business, government and other organizations has increased the demands made on accountants and thus has emphasized the need for extensive education and training. While it is still true that many accountants begin as bookkeepers or as apprentices, have little formal education and develop on the job, a college education is generally recognized as a highly desirable if not necessary requirement. Early education for accounting careers was confined largely to the functional branches of business, narrowly conceived, with a heavy load of how-to-do-it courses in accounting practice

as it then existed. Many of the quantitative requirements of the profession are now furnished by courses in statistics, mathematics. econometrics, engineering and related subjects. so that accounting courses are tending to become integrating courses with stress on professional and managerial adaptation to a changing environment.

Formal instruction in accounting nas limited to public and private secondary schools until the late 19th century. In 1883, the Wharton school of finance and commerce of the University of Pennsylvania included an accounting course as part of the regular curriculum, and by 1900 accounting courses were offered at The University of Chicago and New York university.

Growth of the field and increased demands on practising accountants have led to the recommendation for a 5-year program of professional education for accounting. The American Institute has been active in education, and the American Accounting Association was organized in 1916 primarily for collegiate instructors and students of accounting. Many of the articles in The *Accounting* Review (1926) relate educational material to the teaching of accounting theory and practice.

Accounting courses for collegiate academic credit are less generally offered in universities in Europe than in the United States Much basic instruction for public accounting in Great Britain is carried on by correspondence schools or through noncredit courses in the colleges and universities, but departments of accounting have been created in a number of universities. Emphasis is placed upon the economic and administrative aspects of the subject rather than training for careers in public accounting.

German universities regard accounting as an integral part of business administration (Betriebswirtschaft). Instruction places primary emphasis upon accounting as a tool of control, with special attention to such aspects as cost analysis and budgetary control. The public accountant (Wirtschaftsprufer) offers opinions on the efficiency of management as well as on the accuracy and completeness of financial statements.

Educational training for public accounting in Canada is accomplished mainly through correspondence and special courses conducted by the provincial institutes of chartered accountants, but some instruction is offered at universities and colleges. See also AUDIT; BOOKKEEPING; COST ACCOUNTING; INCOME: ECONOMIC DEFINITION; OFFICE MACHINES AND APPLIANCES; VALUE.

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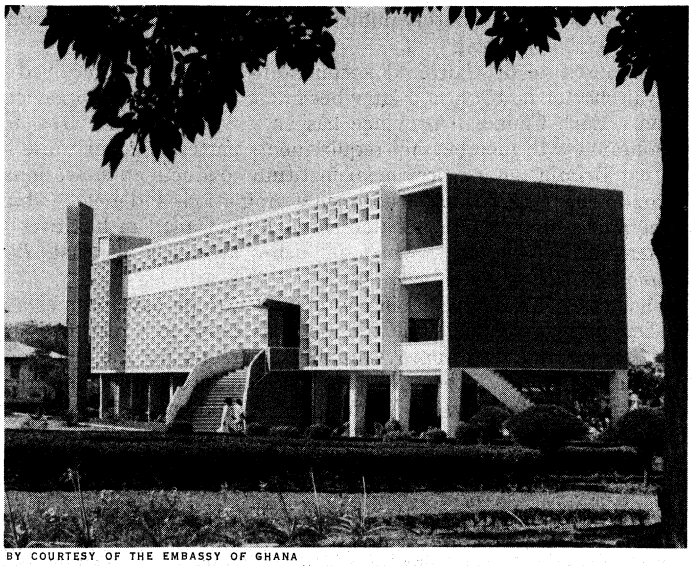
ACCRA, capital, seaport and largest city of Ghana, formerly the Gold Coast. Pop. (1960) 388.231. The climate is warm and dry (temperatures, 73° to 86° F; relative humidity, 81%; average rainfall, 29 in. falling during two rainy seasons on 71 days in the year). The town lies in an earthquake zone and has suffered from shocks, one of the most serious of which occurred in 1939. The name Accra seems to be a Europeanization of *nkran* (literally, "black ant"), applied by the Akan peoples of the Gold Coast to the Ga groups who, in the 16th century, arrived from Nigeria to settle on the Accra plain and to mingle with its inhabitants. The town lies partly on a cliff, 25 to 40 ft. high. and spreads northward over the undulating plains. The cliff projects at three points to form coves that afford partial shelter for the landing of boats through the surf. During the latter part of the 16th century the Portuguese possessed a fortified trading post on one of these points. In the 17th century the English built Ft. James on the westernmost promontory, the Dutch built Ft Crèvecoeur on the point ½ mi. to the east. and the Danes built Christiansborg castle on the promontory at Osu, 1½ mi. along the coast. The attractions of trade with these European nations caused the Ga to move their towns from inland to sites under the walls of the forts.

Accra developed from the settlements by the Dutch and English forts. The people of Osu were a politically distinct community,



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though today the built-up area of Accra includes Osu and extends even farther east. Christiansborg and Ft. Crèvecoeur (renamed Ft. Ussher) were transferred to the British in 1850 and 1872 respectively, and in 1876 Accra replaced Cape Coast as the administrative capital of the British colony. The principal public buildings of the capital, including government departments and the supreme court, were built between Christiansborg castle (formerly the governor's residence, now the official residence of the prime minister) and the old mercantile town. Higher ground to the north was laid out as a residential area for senior government officers. Still farther inland are large military cantonments and the airport, extensively developed during World War II and since used by international services of British, U.S.. French, Portuguese and other airlines as well as by local services. A new international terminal building and another for internal services, as well as other improvements, were completed in 1957.

After 1961, Accra was largely superseded by an artificial harbour at Tema, 17 mi. E., to which it is linked by rail and road. Accra remains a busy port with about 1,000 tons a day being handled by surfboats. A 450-yd. breakwater running eastward from the Ft. James promontory affords increased shelter to the landing beach. The main export from Tema is cocoa. brought from points on the railway via Accra which extends 189 mi. inland to Kumasi, and on the numerous roads serving the hinterland.

From Accra tarred arterial roads lead westward along the coast to Cape Coast and Takoradi, eastward to Togoland and north to Kumasi and beyond.

Accra has electricity and piped water supplies, and an extensive municipal bus service. Besides the three forts, notable buildings include the State house, Parliament house, Korle Bu hospital, the Anglican and Roman Catholic cathedrals and many other churches. the Independence arch. the law courts, the law school, the National museum, the Central Ghana library, Broadcasting house, the Ambassador hotel. the offices of the Bank of Ghana, the Cocoa Marketing board and other public corporations, and the stores and offices of the major European trading concerns. On the northern outskirts are Achimota school, the leading secondary school in the country, opened in 1927; and, at Legon, the extensive new buildings of the University College of Ghana, founded in 1948 at Achimota. (J. D. F.)

ACCRINGTON, a municipal and parliamentary borough in Lancashire, Eng., 5 mi. E. of Blackburn. Pop. (1961) 40,987. Area 6.9 sq mi. It lies in the valley of the Hyndburn, a feeder of the Calder, on the western flank of the Pennines. The name of Accrington is said to derive from O.E. *Aecerntūn*, "village where acorns grow." The De Lacys were lords of the manor of Accrington (Akarinton from 1194) in Norman times, and about 1200 it was given by Robert de Lacy to the Cistercian monks of Kirkstall.

Returned for a time to the De Lacys in 1287, it had so developed by 1507 that a "New Accrington" was created. Old and New Accrington, straggling villages with about 5,000 inhabitants in 1836, were united in 1853 by which time textile print works and cotton mills were employing many people. The population, 17,688 in 1861, increased with the development of the Lancashire coal fields; the town was incorporated in 1878. Cotton and artificial-silk weaving, printing and dyeing and textile machinery manufacture, together with brick- and tilemaking and engineering, form, with the collieries, the industry of the area. The church of St. James, rebuilt in 1763, dates from 1546; the original chapel was probably an oratory which was an offshoot of Kirkstall abbey. Ecclesiastically Accrington was dependent on Altham till after the mid-19th century. The Haworth art gallery contains mostly British paintings. Five miles north-northeast, at Whalley, are the remains of a 13th-century abbey, belonging partly to the Church of England and partly to the Roman Catholics.

ACCULTURATION, the processes of change in artifacts, customs and beliefs resulting from the contact of peoples of different cultural backgrounds. The term is also used to refer to the effects of those processes, as in "an acculturated Navaho Indian," meaning a Navaho who has adopted Anglo-American behaviour while retaining some traditional Navaho ways. The word "acculturation" was first given currency in the late 19th century by U.S. anthropologists interested in the changing cultures of North American Indians. German anthropologists later also employed the term., Not until the 1930s, however, did it assume the status of a technical term in anthropology.

Anthropologists speak of the whole way of life of a people—the body of techniques, behaviours and ideas transmitted from one generation to another—as a culture. Cultures constantly change. A culture may change, on the one hand, as a result of innovations from within, that is, through discoveries and inventions. On the other hand, a culture may change as a result of influences from without, that is, through contact of its bearers with persons of a different culture. Acculturation includes those processes of change which result from contact conditions.

While it is recognized that acculturation has been instrumental in the building of every civilization, the processes have been studied thus far chiefly as they have operated in the spread of western civilization. It has been possible, especially during the 20th century, to make direct observations on the response of native peoples to different varieties of contact with European and European-derived peoples.

Incorporation.—Two major types of acculturation may be distinguished. One takes place when people of different cultures maintain an interchange without the exercise of military or political domination by one group over another. Such conditions were the rule during the long period of human development prior to the appearance of conquest states, but they have also existed more recently. An example of this type of free "borrowing" of cultural elements was that which took place during the 18th century between Spanish colonists and Navaho Indians in the area now called New Mexico. Unconquered by the Spaniards, the Navahos remained a free tribe at the Spanish colonial frontier. Frequent contacts occurred, ranging from trade in seasonally established markets to raids in which Navahos appropriated sheep and horses from Spanish settlements and Spaniards carried off Navaho captives as slaves. Under these conditions Navahos selected livestock, clothing, metalworking techniques and other elements of Spanish culture, integrating these into their own culture in their own way. The result was a culture new in content but with an organization that remained basically the same from the 18th into the 20th centuries. This kind of free borrowing with modification of customs to fit the borrowers' culture has been called incorporation.

Directed Change.—The second general type of acculturation takes place when one people establishes dominance over another through military conquest, political domination or other means of control. This has been called directed culture change in reference to the fact that whenever one people establishes control over another it seeks to change in some degree the way of life of the dominated group. It has been an important form of change ever since conquest states came into existence and it continues to be of great importance in the modern world. Extensive programs of directed change characterized the Roman conquest of the Mediterranean region and western Europe, the Spanish conquest of South and Central America, the British and American conquest of the Indians of Canada and the United States, the European domination of Africa, the Russian conquest of central Asia and Siberia and many other political expansions in the ancient and modern worlds.

Although they also involve selection and modification, the processes of directed culture change are more varied and their results more complex than those that take place under conditions of free contact. This is true because the changes are the result of interference in one cultural system by the agents of another. The determinants of change derive not from a single culture but from two or more in complex interaction. Three important processes which come into operation under various conditions of directed change may be discussed under the heads of assimilation, fusion and reaction.

Assimilation.—A term frequently used by anthropologists and sociologists to refer to the process by which one culture is replaced by another is "assimilation." It may also be used to refer to the replacement of single traits or trait-complexes. It is commonly believed by members of dominant societies that the cultural assimilation of subordinated ones is inevitable, as illustrated in American views concerning the future of North American Indians. Actually complete assimilation rarely takes place, unless the subordinated people are relocated and their family units broken up. The great diversity of local and regional cultures in Europe, despite centuries of conquest and recurrent attempts to force assimilation, testify to the rarity of the process continuing to completion. Some of the most notable instances of assimilation have taken place in the United States. A well-known one is that of the Negro slaves brought from Africa. The tribal cultures of the Negroes were almost completely replaced—languages, social organization, religions, as well as economic life. This came about under conditions of complete uprooting and breakup of family organization. However, even under such conditions some features of the older cultures survived. Another notable instance of assimilation is that of the millions of European immigrants to the United States, who through relocation, the influences of the public-school system and other forces in American life became almost completely assimilated within two or three generations.

Blending.—A commoner result of directed change is a blending of the cultures Brought into contact, a process called fusion, accommodation or syncretism. Most of the North American Indian cultures in the area of the United States have undergone fusion, although this has been accompanied by varying degrees of replacement. The reservation system in the United States has operated strongly to set up conditions favouring fusion rather than assimilation. The results of fusion, embodying intricate combinations of Spanish, Anglo-American and various Indian elements, are to be seen in the cultures of the Pueblo Indians of New Mexico. The cultures of the Iroquois in the state of New York, the so-called "full-blood" Cherokees in Oklahoma, the Crow and other Plains Indians, as well as many others exhibit combination of elements from different cultures. In a more pervasive fashion among a far larger native population the results of similar fusional processes are to be seen in many parts of rural Mexico, Guatemala and South America. New syntheses of cultural elements, combining European and African or European and Asiatic cultures, seem to be a characteristic product of European expansion in the 20th century, as exemplified in India, Indonesia and west Africa. In such areas the processes of acculturation have resulted not in complete assimilation but rather in the formation of new cultures, which, with political autonomy, have begun their own independent courses of development, very much as new cultural syntheses arose after the termination of the Roman conquest.

Reaction.—A third common form of response to directed contact has been called reaction. It involves reaction against aspects of the culture of a dominant group by members of the subordinated society. Such reactions frequently take the form of nativistic

movements. One of the most famous was the Ghost Dance among Paiute, Plains and other Indians of North America. This was a new religious cult led by a Paiute Indian named Wovoka in the 1880s. Wovoka, inspired by supernatural visions, preached a future in which white men would be eliminated and the old way of life restored. To bring this about it was necessary to dance the Ghost Dance, in the course of which dancers communicated with the dead ancestors. The cult spread rapidly among Indians in western United States and culminated in the tragic massacre at Wounded Knee creek. South Dakota. Similar forms of reaction against European domination have occurred repeatedly, such as the Vailala Madness among New Guinea natives and the Mau Mau rebellion among the Kikuyu of Kenya, Africa.

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ACEPHALI, the latinized form of a Greek word meaning "those without a head," has been used chiefly of the following:

1. According to Herodotus (iv, 191), a race of headless men in Libya whose eyes were in the breast, a characteristic which the elder Pliny's *Naturalis historia* (iv, 46) ascribed to the Blemmyae.

2. The strict Monophysites who rebelled against Peter Mongus, the patriarch of Alexandria, by refusing to accept the mediating formula (Henoticon) promulgated in 482 by the emperor Zeno to secure the union of Monophysites and Orthodox. Their most famous adherent was Severus, patriarch of Antioch (512–518; d. 538). whose followers continued for several centuries to be called acephali.

3. Those clergy, also called *clerici vagantes,* who in the middle ages were not attached to a benefice. usually because they were still university students. For their activities *see* GOLIARD.

ACERACEAE, the maple family of plants, comprising about 200 species of .trees and shrubs in two genera, *Dipteronia* (two species) of central and southern China, and *Acer,* the maples, widely distributed in the northern hemisphere, crossing the equator only in Malaysia. In *Dipteronia* the seed is surrounded by a wing; in *Acer* it is winged only on the back. About 15 species of *Acer* are native to the United States. Leaves of Aceraceae are opposite, simple or compound, and usually toothed or lobed. The small. clustered flowers are mostly unisexual (that is, they are either pistillate or staminate) and are sometimes without petals. The fruit a samara, splits into two (rarely three) winged, one-seeded parts. Many maples are cultivated for ornament and shade, including sugar maple (*A saccharum*), Japanese maple (*A palmaturn),* Noraay maple (*A. platanoides*), etc (*see* MAPLE). All maples have a watery, sweet sap that in some species, especially sugar maple, is used to make sirup and sugar. Certain species of *Acer* are also important timber trees. In geologic times the genus *Acer* extended into what is now the arctic region, and *Dipteronia* grew in North America. (J. W. TT.)

ACERRA, in Roman antiquity, a small box or pot for holding incense, as distinct from the turibulum (thurible) or censer in which incense was burned. The name was also given by the Romans to a small altar of incense placed near the dead before the funeral. In ecclesiastical Latin the term acerra is still applied to the incense boats used in the Roman ritual.

ACESTES (Gr. AEGESTES) was a mythological king of Segesta (Gr. Egesta) in Sicily. His mother, Egesta, had been sent from Troy by her parents to avoid feeding her to a voracious sea serpent that was ravaging the city because of Poseidon's anger against Laomedon (*q.v.*). Going to Sicily she met the river-god Crimisus, who appeared as a bear or a dog and by whom she became the mother of Acestes.

Acestes appears notably in the *Aeneid,* offering hospitality to Aeneas when he lands in Sicily (book 5). His function is to emphasize the mythological connection of that island with Troy: in Greek legend Aeneas traveled no farther than Sicily. Acestes brings the funeral games of Anchises to a climax by shooting into the air an arrow that becomes a comet. a sign of Anchises' eternal life (and a deliberate suggestion of the comet that appeared at Caesar's funeral games in 44 B.C. and that was hailed as proof of his divinity). (T. V. B.)

ACETALDEHYDE, an aldehyde important as an intermediate product in the synthesis of acetic acid, n-butyl alcohol, ethyl acetate and other chemical compounds. It occurs in crude ethyl alcohol (*q.v.*) obtained by the fermentation of sugars and in crude methyl alcohol obtained by the destructive distillation of wood. Manufacture is by the oxidation of ethyl alcohol and the hydration of acetylene (q v.). Acetaldehyde is transformed by reduction into ethyl alcohol and by oxidation into acetic acid (*q.v.*). The molecular formula is C_2H_4O and its structure is CH_3CHO. *See* also ALDEHYDES AND KETONES: *Aldehydes.*

ACETAMIDE: *see* AMIDES.

ACETANILIDE (ANTIFEBRIN) is a drug made by interaction of glacial acetic acid with aniline (*q.v.*) and used in medicine to reduce fever. It does nothing to remove the cause of the fever and may result in aniline poisoning, a depressant action on the heart muscle resulting in collapse, nausea. vomiting and blueness of lips and nails. The last is caused by chemical changes in the blood, whereby red corpuscles lose their power to carry oxygen.

Acetanilide is a white, crystalline substance melting at 115° C., boiling at 305° C. and soluble in water, alcohol or ether. Its chemical formula is $C_6H_5.NH.CO.CH_3$.

ACETATES: *see* ACETIC ACID.

ACETIC ACID is the most important member of the carboxylic acid group (*see* CARBOXYLIC ACIDS). It is produced on a vast scale technically, and the two principal methods which are now used for its preparation involve either biological oxidation (vinegar manufacture) or its synthesis from acetylene. Acetic acid is an important intermediate in many biosynthetic reactions, and it occurs naturally as a constituent of biological fluids and plant juices.

Pure acetic acid ($CH_3.CO_2H$) is often called glacial acetic acid. It is a colourless liquid (boiling point, 118° C.; melting point, 16.7° C.) which is completely miscible with water. The liquid has a corrosive action.

Manufacture. — Many processes have been devised for the synthesis of acetic acid on a technical scale. The steps which form the basis of most of these methods are (1) the preparation of acetylene from calcium carbide, $CaC_2 + 2H_2O \rightarrow Ca(OH)_2 + C_2H_2$; (2) the catalyzed hydration of acetylene to acetaldehyde, $C_2H_2 + H_2O \rightarrow CH_3.CHO$, which takes place in dilute sulfuric acid with mercuric sulfate as the catalyst; (3) the vapour-phase oxidation of acetaldehyde to acetic acid (*see* below). This process constitutes a very simple method for the synthesis of acetic acid, and the starting material, calcium carbide, is easily prepared by an electric arc process from limestone and coal.

The manufacture of vinegar consists of a fermentation process whereby carbohydrates such as starch, sugar or malt are fermented to yield ethyl alcohol, and this ethyl alcohol is then oxidized to acetic acid (*see* below). There are numerous species of aerobic bacteria (*e.g., Acetobacter aceti* and *A. pasteurianum*) which may be used to effect the oxidation. Various names are used to describe vinegar, including malt vinegar and cider vinegar, and these indicate the origins of the carbohydrates used in the fermentation process. Vinegars usually contain about 5%–10% of acetic acid.

The oxidation of ethyl alcohol to acetic acid proceeds through acetaldehyde as an intermediate.

$$CH_3.CH_2OH \rightarrow CH_3.CHO \rightarrow CH_3.CO_2H$$

This reaction may be achieved either by using oxidizing agents, such as potassium dichromate and dilute sulfuric acid; or by vapour-phase oxidation in which a mixture of air and ethanol is passed over a heated vanadate catalyst. The biochemical oxidation of ethyl alcohol involves enzymes of the dehydrogenase type. (The souring of wines is due to the oxidation of the contained ethyl alcohol to acetic acid.)

Industrial Uses.—Acetic acid is used in the preparation of (1) metal acetates which are used in some printing processes; (2) the plastic polyvinyl acetate; (3) the further plastic cellulose acetate, which also finds extensive use in photographic films and in textile fibres (rayon); and (4) volatile esters such as ethyl acetate and amyl acetate, which are used extensively as solvents for resins, paints and lacquers. Amyl acetate is used as a flavouring agent in confectionery.

See also Index references under "Acetic Acid" in the Index volume. (W. D. Os.)

ACETOACETIC ESTER, or ethyl acetoacetate, an organic compound used industrially in the manufacture of synthetic drugs and dyes, is an outstanding example of a chemical substance having a dual chdracter arising from the possession of tno different molecular structures. Such substances are called tautomeric compounds. The substance is an ester, and has the molecular formula $C_6H_{10}O_3$. The two tautomeric forms are represented by

$CH_3COCH_2COOC_2H_5$ (ketonic form) **and**
$CH_3C(OH):CHCO_2C_2H_5$ (enolic form)

ordinary specimens of the ester as handled in commerce may be regarded as consisting of 93% of the first in equilibrium with 7% of the second. When treated by reagents which combine with ketones, such as sodium bisulfite hydroxylamine, phenylhydrazine and hydrocyanic acid, the ketonic character of the ester is manifested. and when acted upon by reagents such as phosphorus pentachloride, diazomethane, ammonia and amines, which detect alcoholic (enolic) groups, then its enolic nature is revealed.

In 1911 L. Knorr separated the two forms of the ester in a state of purity. The ketonic modification was frozen out of the equilibrium mixture at −78° C. and the enolic modification was isolated in the liquid condition by decomposing the sodium derivative with hydrogen chloride at the same low temperature. In these experiments it was found to be essential to use silica vessels. The ester was first discovered by A. Geuther in 1863. The original method of production is still employed on a manufacturing scale. Sodium, either molten or in wire form, is added to dry ethyl acetate containing a little ethyl alcohol. When all the metal has dissolved, the mixture is acidified with dilute acetic or sulfuric acid and the crude acetoacetic ester, which is partially miscible with water, separates as an oil on addition of common salt and is purified by distillation under diminished pressure. The ester is a colourless, fragrant liquid and boiling, with slight decomposition, at 181° C. under a pressure of 760 mm.

In the chemical laboratory acetoacetic ester is a valuable synthetic reagent, for its sodium derivative when acted on by an alkyl iodide yields an alkylacetoacetic ester, and the sodium derivative of the latter ester by similar means furnishes a dialkyl-acetoacetic ester. These alkyl- and dialkyl-acetoacetic esters may be employed in producing either higher ketones or higher fatty acids.

The ester has also been employed in the synthesis of pyridines, quinolines. furans, pyrazoles, pyrroles and compounds of the purine group.

ACETONE is an organic solvent of industrial and chemical importance, and is the simplest representative of the aliphatic ketones (see ALDEHYDES AND KETONES). It has very useful solvent properties, dissolving many fats and resins as well as cellulose nitrate and acetate. Because of the latter properties. it finds extensive use in the manufacture of explosives and artificial fibres The numerous important chemical reactions of acetone make possible many organic syntheses in the laboratory and in industry.

Physiologically, acetone is present in the urine and in the blood; larger quantities are detected in diabetic patients. The ketones in general give rise to narcosis and lowering of blood pressure. Acetone itself produces intoxication and sleep but is less powerful than ether or chloroform, although less toxic than ethyl alcohol. When treated with chlorine, bromine or iodine in the presence of alkali, acetone is converted respectively into chloroform, bromoform or iodoform. It is the starting point in the production of the narcotic drug sulfonal.

Because of its valuable properties as a solvent and as an organic reagent, acetone is prepared commercially on a large scale, the processes available being as follows:

1. The dry distillation of calcium acetate leading to the formation of acetone and calcium carbonate.

2. The catalytic decomposition of glacial acetic acid into acetone, carbon dioxide and water when it is passed over heated metallic oxides such as alumina and thoria.

3. The fermentation of corn (maize), rice, horse chestnut meal or other starchy materials with a bacterium discovered by A. Fernbach, the starch present being converted into a mixture of normal butyl alcohol (6 parts), acetone (3 parts) and ethyl alcohol (1 part).

4. The dehydrogenation or oxidation by air of isopropyl alcohol in the presence of heated metallic or metal oxide catalysts.

Acetone has the molecular formula CH_3COCH_3 and is thus dimethyl ketone. It is a colourless, fragrant, inflammable, mobile liquid, boiling at 56.3° C. and miscible in all proportions with water, alcohol and ether.

See J F. Thorpe and M. *A.* Whiteley, *Thorpe's Dictionary of Applied Chemistry* (1937).

ACETOPHENONE or phenyl methyl ketone, is an organic compound with anesthetic and soporific properties;.under the name hypnone it has been used as a drug to induce sleep. It is the simplest representative of the mixed aliphatic-aromatic ketones. Acetophenone melts at 20° C. and boils at 202° C., is volatile in steam and has the composition, $C_6H_5COCH_3$. It occurs to a small extent in coal tar and, having feebly basic properties, is extracted from the heavy oil fractions (boiling point 160°–190°) with sulfuric acid.

ACETYLENE is a colourless, gaseous hydrocarbon, widely used as a fuel in oxyacetylene welding and cutting of metals, and as a chemical intermediate in the synthesis of many organic chemicals and plastics. It was discovered and identified in 1836 by Edmond Davey. The properties of acetylene were first determined in 1862 by M. Bertholet who also showed that acetylene is formed in many high-temperature pyrogenic reactions; for example, acetylene is usually present in small amounts in coal gas. However, it was not until the discovery by Willson and Moorehead in 1892 of the electric furnace method of producing calcium carbide from the combination of coal with lime that acetylene became of any commercial significance. Acetylene, generated when calcium carbide is brought in contact with water. was used for illumination because the acetylene flame. when supplied with the correct amount of air, gives a pure white light which is the nearest known artificial approach to sunlight. The widespread use of acetylene for illumination during the early part of the century has been supplanted by the incandescent electric light, except for locations where electric power is not available; *e.g.*, in navigation buoys and miners' lamps.

The next stage in the growing importance of acetylene as an industrial commodity was the development of autogenous welding using an oxygen-acetylene flame in the so-called oxyacetylene torch. This oxyacetylene flame produces the highest flame temperature (about 6,000° F.) of any known mixture of combustible gases and, although originally limited to welding and joining of certain ferrous metals, can now be used to weld or cut practically all industrial metals.

Acetylene is an unsaturated organic compound, highly reactive toward many chemical reactants. so it soon became the basis for a rapidly growing chemical industry. Acetaldehyde, acetic acid, acetone and a wide range of chlorinated solvents were so derived. During the early 1930s, E. I. du Pont de Nemours and Co. developed in the United States the first synthetic rubber, Neoprene (Duprene) from acetylene. Subsequently the use of acetylene in chemicals continued to widen until more than 75% of the acetylene used was employed in synthetic chemicals, many of which appeared as such familiar household articles as water-base paints, vinyl fabric and floor coverings, dry cleaning solvents and aerosol insecticide sprays.

Manufacture of Acetylene. — Until about 1940, acetylene was usually derived from calcium carbide, the product of the reaction

of coal and lime in an electric furnace at about 2,000° C.

$$3C\ (\text{coal}) + CaO\ (\text{lime}) \xrightarrow{\text{heat}} CaC_2\ (\text{calcium carbide}) + CO\ (\text{carbon monoxide})$$

Reaction of water with calcium carbide in specially designed generators produces gaseous acetylene and solid hydrated lime.

$$CaC_2\ (\text{calcium carbide}) + H_2O\ (\text{water}) \longrightarrow HC{\equiv}CH\ (\text{acetylene}) + Ca(OH)_2\ (\text{hydrated lime})$$

During World War II Germany installed in the synthetic rubber plant at Huls the first successful commercial installation for the cracking of hydrocarbons to acetylene by means of a high temperature electric arc. During the same period, Germany also operated a plant at Oppau for the production of acetylene by partial combustion of methane with air or oxygen. The combustion of part of the methane provided the heat required to raise the temperature of the injected hydrocarbon up to the cracking temperature. This latter process, sometimes referred to as the Sachsse process, later was further developed, particularly in the southwest United States where ample supplies of natural gas are available cheaply. Unlike the calcium carbide or arc processes, the Sachsse process does not require electrical power as a primary source of energy. Still a fourth method, a purely thermal hydrocarbon cracking process known as the Wulff process, is carried out in a regenerative type furnace consisting of carborundum refractory tiles in the heated section. The heat required to raise the temperature of the tiles to the cracking temperature of 1,250–1,450° C. is supplied by burning the waste gases, consisting of carbon monoxide and hydrogen, from the purification section.

One fundamental requirement in all high temperature cracking operations for producing acetylene is that the hydrocarbon feed be heated to the highest possible temperature in the shortest possible time and that the temperature of the cracked gases be lowered rapidly to minimize decomposition of the acetylene produced.

Acetylene generated from carbide is generally rather pure, containing less than 0.4% impurities, and is suitable for most uses except chemical synthesis, for which traces of phosphine, arsine and hydrogen sulfide must be removed to prevent poisoning sensitive catalysts. On the other hand, acetylene generated from cracking of hydrocarbons is in very dilute form, comprising only about 8% to 16% of the total gas. Purification may be carried out by several methods but, in principle, all depend on the selective absorption of acetylene in a solvent, generally under pressure. in which, the acetylene is many times more soluble than the attendant impurities. This solvent stream, containing principally acetylene, when warmed up at lower pressures, releases the acetylene in fairly pure state. A major by-product in all cracking operations is a considerable amount of finely divided carbon, separation and disposal of which is often troublesome.

A substantial factor in the cost of pure acetylene from cracking operations is the expense of purification. In some cases this can be offset partially by processing the waste "tail gas," consisting essentially of carbon monoxide and hydrogen in roughly the correct percentages for synthesis of methyl alcohol (methanol), a useful industrial chemical. In other instances the carbon monoxide may be removed, leaving essentially pure hydrogen, also useful for chemical synthesis, for example, by reaction with nitrogen from the atmosphere to form ammonia, the basis of several forms of nitrogenous fertilizers.

Despite the wide differences in manufacturing technology, no one of these methods is universally used. Where electrical power is cheap and hydrocarbons scarce, the carbide method probably is prevalent, but where hydrocarbons are plentiful, as in the southwest United States, some form of hydrocarbon cracking is the method of choice.

Shipping of Acetylene. — Because of its inflammability and explosive nature under pressure, acetylene must be shipped in special containers, so constructed as to minimize danger. One basic feature of safe construction lies in packing the cylinders with a highly porous monolithic filler so that no pockets of significant size remain where free acetylene in gaseous form can collect. A second factor is the use of a solvent, acetone, which dissolves many times its own volume of acetylene. By this technique, acetylene can be shipped safely at pressures of 250 lb. per square inch (p.s.i.). Even so, in the United States the construction and shipping of acetylene cylinders must follow the specifications and regulations of the Interstate Commerce commission.

From the above, it is obvious that the weight of acetylene available in each cylinder is very small, usually less than 10% of the total shipping weight. If one takes into account the return of the empty shipping container, the net efficiency of shipping is less than 5%. On the other hand, calcium carbide gives off 31% of its weight of acetylene and is thus the cheapest form in which to transport acetylene by common carrier.

Fuel Uses. — Acetylene requires 2.5 times its volume of oxygen or 11.95 times its volume of air to effect its complete combustion. It is used for lights in portable lamps, buoys, road signals, isolated premises, etc., but the consumption of acetylene for lighting is small compared with its use in the industrial welding and cutting of metals, for which purposes it is consumed in a blowpipe to which a supply of undiluted oxygen is fed from a steel cylinder containing that gas under pressure. In welding, a reducing flame is maintained by using less than the proportion of oxygen required for complete combustion, whereas in cutting metals an excess of oxygen is admitted to oxidize the metal. Since acetylene is an endothermic compound its heat of combustion is greater than that of the constituent carbon and hydrogen. For this reason acetylene affords a higher flame temperature than other fuel gases, about 6,000° F. in a correctly designed and operated torch.

Chemical Uses. — Ready availability. high reactivity and reasonable cost make acetylene a suitable starting material for the industrial synthesis of many organic chemicals. Together with ethylene, it forms the basis of much of the synthetic aliphatic chemical industry. In those countries having abundant electrical power but limited oil reserves, acetylene is usually favoured as a raw material. However, in the United States acetylene and ethylene are often competitive; acetylene is generally more expensive than ethylene but processing costs may be lower because, in many cases. acetylene may offer a more direct route to the desired chemical. The use of acetylene as a raw material for chemical synthesis has increased so rapidly that total usage in the United States may be expected to increase tenfold — up to about 3,000,000,000 lb. per year by 1975.

Many potentialities of acetylene as a raw material for synthetic products have been realized, primarily by J. W. Reppe in Germany; knowledge of Reppe's work became generally available only after World War II. Reppe recognized that inability to handle acetylene safely under pressure was a very serious limitation to the discovery of new reactions of acetylene. He initiated an exhaustive study of the explosive characteristics of acetylene, as a result of which new techniques were devised which permitted acetylene to be used in chemical reactions under pressures of up to 250–300 lb. p.s.i. In brief, these techniques involved: (1) dilution of the acetylene with an inert gas such as nitrogen; (2) use of small-bore transmission lines; and (3) subdivision of all large areas of the container by packing with ceramic or metal rings or gauzes so that no acetylene molecule was more than one-half inch from a wall surface.

With these new techniques allowing the use of acetylene under pressure, Reppe was able to develop four new areas of acetylene chemistry: (1) vinylation, in which an alcohol, mercaptan, acid. amine or amide is added across the triple bond to produce vinyl ethers, vinyl thioethers, vinyl esters, vinyl amines and vinyl amides; (2) ethynylation, in which the acidic hydrogens are added to aldehydes, ketones and amines to produce new acetylenic chemicals, still containing a triple bond; (3) carbonylation, in which carbon monoxide may be added in the presence of water or alcohol to give acrylate derivatives; and (4) cyclopolymerization, in which acetylene reacts with itself to produce cyclic hydrocarbons such as benzene, styrene and cyclooctateraene.

This new chemistry of acetylene under pressure, sometimes referred to as Reppe chemistry, has made available many new acetylene chemicals, but few had obtained large-scale usage in the early