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PARTIAL LIST OF CONTRIBUTORS TO VOLUME XXVI

ALDEN, RAYMOND M., Ph.D., Litt.D.
Professor of English, Leland Stanford Jr. University
TOTTEL'S MISCELLANY

ALEXIS, JOSEPH, A.B., A.M.
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Professor of Romance Languages, University of Michigan
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New York City
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DAKE, CHARLES LAURENCE, A.M.
Associate Professor of Geology and Mineralogy, School of Mines and Metallurgy, University of Missouri
TERTIARY PERIOD

DARTON, NELSON H.
Geologist, United States Geological Survey
SURVEYS, UNITED STATES GOVERNMENTAL

* Deceased.

Contributors to Volume XXVI — Continued

DAVENPORT, EUGENE, B.S., M.S., M.Agr.
Dean of the College of Agriculture, University of Illinois

THREMMATOLOGY

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Chancellor of Syracuse University

SYRACUSE UNIVERSITY

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Assistant Professor of German, Harvard University

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Horticultural Consultant

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Head of English Department, Vanderbilt University
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University of Pennsylvania
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Author of "Platonism," etc.
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NEWCOMB, SIMON, Ph.D., LL.B., D.Sc.*
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Professor of Astronomy and Director Flower Astronomical Observatory, University of Pennsylvania
SUN

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Secretary, Syracuse Chamber of Commerce
SYRACUSE, NEW YORK

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Mining Engineer, San Francisco, Cal.
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Editorial Staff of The Americana
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Author of "Text Book of Surgery"
VANDER VEER, ALBERT, M.D.
Professor of Anatomy 1869–74; Professor of Surgery 1876–1915, Albany Medical College
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POLLOCK, HORATIO M., Ph.D.
Statistician, New York State Hospital Commission
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Tennessee Historical Society, Nashville, Tenn.
TENNESSEE

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Director of Technical Research, The Travelers' Insurance Company, Hartford, Conn.
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McVickar Professor of Political Economy and Finance, Columbia University
TAXATION

SHELDON, HENRY C., S.T.B., D.D.
Professor of Systematic Theology, Boston University
THEOLOGY

* Deceased.

Contributors to Volume XXVI—Concluded

SHERMAN, STUART P., Ph.D.
Professor of English, University of Illinois

TALE OF A TUB, A

SINGLETON, ESTHER
Author of "The Art of the Belgian Galleries"

TITIAN

SKINNER, RAYMOND T.
Secretary, The Toledo Commerce Club

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VAN DOREN, CARL, Ph.D.
Associate in English, Columbia University

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VANDER VEER, ALBERT, M.D.
Professor of Anatomy 1869–74; Professor of Surgery 1876–1915, Albany Medical College.

SURGERY

VAUGHAN, VICTOR C., M.D., Ph.D.
Dean, Department of Medicine and Surgery, University of Michigan.

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Of the Warner and Swasey Company, Cleveland, Ohio

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Fellow of the Theosophical Society

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WATSON, WILLIAM R., B.S.
Chief of Educational Extension Division, New York State Education Department, Albany, N. Y.

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Sometime of the Department of Latin, Catholic University of America

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TERTULLIAN

WRONG, GEORGE M., A.M.
Professor of History, University of Toronto

TORONTO, CANADA

* Deceased.

KEY TO PRONUNCIATION.

ä	far, father
ā	fate, hate
a or **ă**	at, fat
ã	air, care
ạ	ado, sofa
â	all, fall
ch	choose, church
ē	eel, we
e or **ĕ**	bed, end
ė	her, over: also Fr. *e*, as in *de*; *eu*, as in *neuf*; and *oeu*, as in *boeuf*, *coeur*; Ger. *ö* (or *oe*), as in *ökonomie*.
ẹ	befall, elope
ẽ	agent, trident
ff	off, trough
g	gas, get
gw	anguish, guava
h	hat, hot
h or **H**	Ger. *ch*, as in *nicht*, *wacht*
hw	what
ī	file, ice
i or **ĭ**	him, it
ï	between e and i, mostly in Oriental final syllables, as, Ferid-ud-din
j	gem, genius
kw	quaint, quite
ṅ	Fr. nasal *m* or *n*, as in *embonpoint*, *Jean*, *temps*
ñ	Span. *ñ*, as in *cañon* (căn′yŏn), *piñon* (pēn′yŏn)
ng	mingle, singing
nk	bank, ink
ō	no, open
o or **ŏ**	not, on
ô	corn, nor
ȯ	atom, symbol
ọ	book, look
oi	oil, soil; also Ger. *eu*, as in *beutel*
ö or **oo**	fool, rule
ou or **ow**	allow, bowsprit
s	satisfy, sauce
sh	show, sure
th	thick, thin
ŧh	father, thither
ū	mute, use
u or **ŭ**	but, us
u̇	pull, put
ü	between u and e, as in Fr. *sur*, Ger. *Müller*
v	of, very
y	(consonantal) yes, young
z	pleasant, rose
zh	azure, pleasure
′(prime), ″(secondary)	accents, to indicate syllabic stress

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S

SULPHUR, a non-metallic element known from very early times, and proved to be an element by Lavoisier, in 1772. It was not definitely admitted to the list of recognized elements, however, until after the researches of Gay-Lussac and Thénard, in 1809. In the free state, it occurs native in many parts of the earth, usually in volcanic regions or in connection with gypsum and other allied rocks. Until within recent years the commercial supply has been obtained largely from Sicily, though a considerable quantity has been obtained from the Chilean Andes, and from certain parts of Mexico, China, Japan, India and the Philippine Islands. The large deposits of southern Utah are also mined, but the American supply is now obtained almost wholly from the extensive deposits in and near Calcasieu Parish, La. Four general methods have been employed for separating sulphur from the stony and earthy impurities with which it is usually associated in nature. (1) The «ore» containing it may be heated to a temperature high enough to melt the sulphur and permit it to run out at the bottom; or (2) the «ore» may be heated still more strongly, so as to cause the sulphur to volatilize and pass away in the form of vapor; or (3) the «ore» may be lixiviated with a fluid (such as carbon disulphide) in which the sulphur is soluble, the sulphur being afterward recovered by evaporating the solvent. (4) The Frasch process, specially developed in connection with the Louisiana deposits, is described below. The method by melting is almost exclusively used in extracting sulphur from the inert material with which it is associated in nature, the volatilization and solution methods being reserved for the subsequent purification of the product as first obtained by melting. When the sulphur is extracted from an «ore,» the heat required for melting it and isolating it is obtained by various means. In some regions it is obtained by burning a part of the sulphur itself. This method is wasteful in sulphur, but it can be put into practice very simply, and hence its application does not call for skilled labor. In Nevada and California, and, to a more limited extent, in Italy and Sicily, the «ore» is heated by steam under a pressure of 70 pounds or more; the yield by this method being considerably greater, though the expense of treatment is also much greater.

In mining the Louisiana deposits a special method is used, which merits separate description. These vast deposits occur in the form of subterranean beds, having an average thickness of 125 feet, and covered by about 90 feet of soft rock (mainly gray limestone) and 375 feet of clay, sand and gravel. The deposits were first discovered in 1865, and between 1868 and 1895 many unsuccessful attempts were made to work them commercially by ordinary methods of mining. Herman Frasch, an American petroleum expert, then undertook a careful study of the subject, and worked out a method of mining the sulphur that has proved eminently successful. The entire practicability of the Frasch process was first established in 1903, in which year 35,000 tons of sulphur were brought to the surface by means of it. The essential ideas of the Frasch process are (1) the use of highly heated water to melt the sulphur as it lies in its bed, and (2) the use of compressed air to force the molten sulphur to the surface of the ground. Several concentrically-arranged steel pipes are driven into the ground, and highly superheated water is forced down into the sulphur bed through the outer ones. The sulphur is thereby melted, and as it is considerably heavier than water it collects in a subterranean pool, into which the pipe system dips. Air, compressed to a pressure of about 250 pounds to the square inch, is forced down the central pipe (which is one inch in diameter), and as this air returns to the surface of the ground through the annular space between the inner pipe and the next one to it, the melted sulphur is carried upward at the same time. When the operation is properly conducted the melted sulphur and hot water can be kept separate, so that when the sulphur reaches the surface it is only necessary to run it into bins to cool and solidify. The product that is obtained in this way is remarkably free from impurities. In fact it is not uncommonly 99.9 (and sometimes even 99.98) per cent pure, and hence it does not require further purification for technical use. For a good technical description of the Frasch process, consult Thorpe's 'Dictionary of Applied Chemistry,' article «Sulphur.»

Iron pyrites (native yellow sulphide of iron) is utilized quite extensively as a source of sulphur in certain lines of manufacture, but the sulphur of the pyrites is rarely won in the elementary form. Almost invariably the sulphur dioxide that is obtained by roasting the pyrites is used in the preparation of sulphuric acid or other compounds, without being reduced to sulphur.

Native crystals of sulphur are common. They belong to the orthorhombic system, and are usually pyramidal in habit, often with truncated ends. They are transparent to translucent, and are usually yellow in color, with a resinous lustre, a hardness of from 1.5 to 2.5, and a specific gravity of about 2.07.

Sulphur occurs abundantly, also, in combination with other elements, mostly as sulphides and sulphates. Many of the compounds of sulphur are valuable as ores of other elements than sulphur. Galena (sulphide of lead) and cinnabar (sulphide of mercury), for example, are valuable ores of lead and mercury, respectively.

It is difficult to give an adequate physical description of sulphur since the element is capable of existing in many allotropic forms. Six of these appear to have been prepared in a state of satisfactory purity, and others, although they have long been known, are not yet universally admitted to be true allotropic modifications of pure sulphur. A brief description of the six best-known forms follows:

1. **Ordinary Rhombic Sulphur.**— This is the form in which native crystalline sulphur occurs. Crystals of this variety may be prepared by dissolving ordinary sulphur in carbon disulphide, and evaporating the solvent. This variety is also obtained by melting sulphur and allowing it to cool with extreme slowness. Ordinary rhombic sulphur melts at about 240° F., and boils (under a pressure of 760 millimeters of mercury at Paris) at 832.2° F., according to the very careful experiments made by Callendar and Griffiths with the normal constant-pressure air thermometer. In the solid form rhombic sulphur has a specific gravity of from 2.03 to 2.09, and in the liquid form (just above the melting point) its specific gravity is about 1.81. It is practically a non-conductor of electricity at ordinary temperatures, although it conducts to some extent near its boiling point. When rubbed, sulphur becomes negatively electrified, and globes of sulphur were used in the place of glass in some of the earlier forms of static electrical machines. Rhombic sulphur has a coefficient of linear expansion of about 0.0000356 (Fahrenheit scale), and, when at a temperature just above the melting point, it has a specific heat of approximately 0.235. It is easily soluble in carbon disulphide, and, to a lesser extent, in benzene, chloroform, warm concentrated acetic acid and liquid sulphur dioxide.

2. **Monoclinic Sulphur.**— Sulphur may be obtained in the form of monoclinic crystals by melting a considerable quantity of ordinary sulphur, allowing it to cool until a crust has formed upon the surface and then piercing the crust and pouring out the still molten portion. The walls of the crucible will then be found to be covered with the monoclinic crystals. It may also be prepared in mass by melting ordinary sulphur, cooling it almost to the point of solidification, and then throwing in a single crystal of monoclinic sulphur; the whole mass then solidifying in the monoclinic form. (If a crystal of rhombic sulphur is added under these circumstances, the crystalline structure of the resulting solid mass is rhombic). Monoclinic sulphur has a specific gravity of about 1.97, melts at about 245° F., and is freely soluble in carbon disulphide, from which it crystallizes in the rhombic form. It also dissolves in alcohol, chloroform and benzene, the crystals obtained from these solutions being partly monoclinic and partly rhombic. Monoclinic crystals may be obtained by evaporating the solution obtained by dissolving sulphur in an alcoholic solution of ammonium sulphide. Monoclinic sulphur passes slowly into the ordinary rhombic form, the transformation being facilitated by rubbing the monoclinic crystals with a glass rod. When heated, under atmospheric pressure, to 203° F., monoclinic sulphur passes at once into the ordinary rhombic form, the transformation being accompanied by a small contraction in volume, and the evolution of a certain amount of heat.

3. **Soft Soluble Sulphur.**—This variety of sulphur may be prepared in various ways,— for example, by decomposing sodium hyposulphite (or thiosulphate) by means of a limited quantity of a mineral acid. It is a soft, amorphous substance, nearly white in color, which gradually hardens, and eventually passes (like all the other kinds) into ordinary rhombic sulphur. This form of sulphur is not (as its name indicates) entirely soluble in carbon disulphide; it consists, apparently, of a mixture of two kinds of sulphur, one of which is soluble, while the other is insoluble. When heated, it evolves sensible quantities of sulphuretted hydrogen, showing that it contains hydrogen in some form or other; but it has not been determined whether such hydrogen is essential to the existence of the sulphur in this form, or whether it is to be regarded merely as a non-essential constituent, which could be eliminated (if we knew how to eliminate it) without affecting the continued existence of the sulphur in the «soft soluble» form.

4. **Plastic Insoluble Sulphur.**—When ordinary sulphur is melted, it first passes into the form of a clear, yellow liquid; but as the temperature is raised, the liquid begins to thicken and darken at about 300° F., and at about 360° F. it is black and quite viscid. If the temperature is still further increased, the liquid gradually loses its viscidity, until, at about 640° F., it becomes quite fluid again, though it remains dark even at its boiling point (832.2° F.). If sulphur which has been heated almost to its boiling point is suddenly cooled by being poured in a thin stream into water, it becomes converted into a plastic mass, which may be readily kneaded with the fingers. Plastic sulphur is commonly dark brown; but Mitscherlich states that the dark color is due to impurities, and that perfectly pure plastic sulphur is citron-yellow in color. Plastic sulphur soon becomes hard and yellow, the transformation taking place quickly (and with evolution of heat) at temperatures in the vicinity of 212° F. It is not soluble, as a whole, in carbon disulphide, though that reagent dissolves a portion of it.

5. **Amorphous Yellow Insoluble Sulphur.** — Plastic sulphur, when treated with warm carbon disulphide until all the soluble part is removed, leaves a yellow, amorphous powder as a residuum. This form appears to be stable at ordinary temperatures, but at about 212° F. it slowly passes into the ordinary rhombic crystalline form.

6. **Colloidal Sulphur.**—When sulphuretted

hydrogen gas is passed into a cold solution of sulphur dioxide, sulphur is liberated in still another allotropic form. If the current of sulphuretted hydrogen is continued until all the dioxide has been decomposed and the solution (after filtration) is concentrated by evaporation in a vacuum, a yellow solid is finally obtained, which is soluble in water, but which gradually passes into the form of ordinary rhombic sulphur. «Colloidal» sulphur receives its name from the fact that in its aqueous solution it is not diffusible.

Sulphur occurs in commerce in several forms. When cast into cylindrical or slightly conical sticks it is known as «roll sulphur» or «brimstone.» It is very brittle under ordinary circumstances, and when reduced to powder by crushing it is sold simply as «sulphur.» When sulphur vapor is suddenly cooled, the sulphur condenses in the form of a very finely divided powder, which is commercially known as «flowers of sulphur,» or «sublimed sulphur.» «Precipitated sulphur» is the fine powder that is thrown down upon the addition of hydrochloric acid to a solution prepared by heating sublimed sulphur with lime and water.

Chemically, sulphur has the symbol S, and an atomic weight of 32.06 if $O = 16$, or 31.81 if $H = 1$. It combines directly with many of the other elements, producing binary compounds which are known as «sulphides,» and which are analogous to the oxides of the corresponding elements. With hydrogen it forms hydrogen sulphide, or «sulphuretted hydrogen,» which has the formula H_2S, and is gaseous under ordinary conditions of temperature and pressure. (See HYDROGEN). Many of the metallic sulphides occur in nature as minerals, as has been already mentioned. Many of them may also be prepared by passing a current of sulphuretted hydrogen gas through acid or alkaline solutions of various metallic salts, or by adding a soluble sulphate to such solutions. See CHEMICAL ANALYSIS.

Several oxides of sulphur are known, of which two are of great industrial importance. These are the dioxide, SO_2, and the trioxide, SO_3.

Sulphur dioxide, SO_2, is prepared, in the laboratory, by treating sodium acid sulphite ($HNaSO_3$) with concentrated sulphuric acid (H_2SO_4); sulphur dioxide and sodium acid sulphate being formed, as indicated by the equation $HNaSO_3 + H_2SO_4 = SO_2 + HNaSO_4 + H_2O$. It is also prepared by heating strong sulphuric acid with metallic copper, the reaction in this case being $2H_2SO_4 + Cu = SO_2 + CuSO_4 + 2H_2O$.

Sulphur dioxide is a colorless gas with the familiar suffocating odor of burning sulphur. It is irrespirable in the pure state, or even when largely diluted with air. Mere traces of it, when inhaled for some time, produce inflammation of the mucous surfaces of the respiratory tract and of the stomach, followed by nausea. The gas is about twice as heavy as air under the same conditions of temperature and pressure. Its specific heat at constant pressure (as compared with an equal weight of water) is about 0.154; and the ratio of its specific heat at constant pressure to its specific heat at constant volume is about 1.256. When exposed to a temperature of 18° F. under ordinary atmospheric pressure, sulphur dioxide condenses to a colorless liquid having a specific gravity of about 1.43. The critical temperature of the gas is probably about 313° F., and the critical pressure about 79 atmospheres. When cooled to about 105° F. below zero, liquid sulphur dioxide freezes to a transparent solid. Liquid sulphur dioxide evaporates rapidly when exposed to the air, the evaporation being attended with the absorption of a very considerable quantity of heat; a temperature as low as 140° F. below zero being attainable in this manner. On account of this property, liquid sulphur dioxide has been employed to a considerable extent in machinery for the manufacture of artificial ice; though at the present time anhydrous liquid ammonia is usually preferred for this purpose. Gaseous sulphur dioxide dissolves freely in water, especially under pressure; the solution being known as sulphurous acid (q.v.).

Sulphur dioxide is prepared in large quantities, in the arts, by the simple process of burning sulphur with a proper supply of air. When obtained in this manner, the gas contains large quantities of atmospheric nitrogen, but for many industrial purposes this is of no importance. The gas is used for bleaching straw, silk and wool, and (in enormous quantities) in the manufacture of sulphuric acid (q.v.). It is likewise employed extensively in the «sulphite process» for the manufacture of paper from wood.

Sulphur dioxide and sulphuretted hydrogen readily combine with each other to form water and free sulphur, according to the equation $SO_2 + 2H_2S = 3S + 2H_2O$; and it has been suggested that the deposits of sulphur that occur in volcanic districts have been formed, at least in part, by this reaction. In bleaching by means of chlorine compounds, it is found to be impossible to wash the last traces of chlorine from the bleached fabric, and hence it is customary to treat the fabric, after the bleaching is complete, with some substance (called an «antichlor») with which the free chlorine will combine, to produce compounds that can be more easily washed out. Sulphur dioxide gas is very useful for this purpose, since it combines with chlorine (in the presence of moisture) to form sulphuric and hydrochloric acids, according to the equation $SO_2 + 2H_2O + 2Cl = H_2SO_4 + 2HCl$. The dioxide is also used as an antiseptic and disinfectant; but it is inferior to chlorine in this respect, and although it possesses germicidal powers to some extent, it is seldom used in sufficient quantities to be really effective in this application.

Sulphur trioxide, SO_3, may be prepared by distilling fuming sulphuric acid, or by passing a mixture of one volume of oxygen with two of sulphur dioxide over red-hot platinized asbestos; the latter method being now used to a considerable extent in the manufacture of sulphuric acid (q.v.) by the so-called «contact process.» The trioxide appears to be capable of existing in two different physical states. The white fumes that are first obtained in the course of its preparation condense into long prismatic crystals, which melt at 62° F. to a colorless, mobile liquid, boiling at 112.8° F. Upon standing, these prismatic crystals are said to change into needle-like forms, which, when heated to about 122° F., pass directly into the gaseous state. Weber has shown that this second form is not observed unless the trioxide contains some measurable quantity of sulphuric acid, due to the action of the trioxide itself upon moisture. Sulphur trioxide has a powerful affinity for water, in which it dissolves with a hissing noise and the formation of sulphuric acid, as indicated by the equation $H_2O + SO_3 = H_2SO_4$. The reaction is accompanied by the liberation of a great deal of heat.

Sulphur combines directly with carbon, at a red-heat, with the formation of a substance known as "carbon disulphide" (or "carbon bisulphide"), which has the chemical formula CS_2. The vapor that is thus produced may be condensed to a very volatile, mobile liquid, possessing a high dispersive action upon light. Carbon disulphide freezes at about — 166° F., boils (under a pressure of one atmosphere) at 115° F., has a specific gravity of 1.29 and a specific heat of 0.247, and is used as a solvent for resins, sulphur, phosphorus, gutta percha and many other substances that do not dissolve in water. It is almost insoluble in water, but mixes readily with alcohol, ether and many kinds of oil. It is exceedingly inflammable, and its vapor forms explosive mixtures with air. The vapor of carbon disulphide takes fire, when heated in contact with air to 300° F., and this circumstance, taken in connection with the volatility of the substance and the explosiveness of its vapor when mixed with air, renders the use of the disulphide exceedingly dangerous in the presence of any sort of a flame, or even in the presence of bodies heated as hot as 300° F. As ordinarily met with in commerce, carbon disulphide possesses an exceedingly offensive odor; but this is due to impurities, and when these are removed, the pure disulphide has an ethereal odor, which is not objectionable. The vapor of carbon disulphide is poisonous, even when greatly diluted with air.

The known compounds that contain sulphur in combination with two or more other elements are almost innumerable, as are also the uses to which sulphur is put in the arts. Among the simpler compounds containing sulphur with two or more other elements, the various salts of sulphurous and sulphuric acids are exceedingly important. For data concerning sulphur black and the sulphur compounds that are in general use in the coal tar color industry, consult Cain and Thorpe, 'The Synthetic Dyestuffs and Intermediate Products'; also Wahl and Atack, 'The Manufacture of Organic Dyestuffs.'

ALLAN D. RISTEEN.

SULPHUR, Medical Uses of. Sulphur is prepared in various ways for use, both internally and externally, in medicine. It is used in the forms of washed, precipitated or milk of sulphur, and sublimed sulphur, or flowers of sulphur, corresponding to the manner of its preparation from crude sulphur — by washing, precipitation, or sublimation. The precipitated sulphur is regarded as the most efficacious, perhaps because of its finer division, which is chemical instead of mechanical. It is prepared by boiling equal parts of sulphur and freshly slacked lime for an hour, and then adding dilute hydrochloric acid until the alkalinity almost disappears. The sulphur precipitates as a white powder and is washed, and dried at a low temperature. Precipitated sulphur is much employed as a mild laxative, taken in medicinal doses and by its action facilitates evacuation in cases where intestinal or rectal disorders painfully interfere. Sulphur is also a valuable remedy in certain blood-diseases, chronic skin-diseases, chronic bronchitis, chronic rheumatism, etc., both internal administration — especially in the form of mineral waters containing sulphur — and sulphur baths being often efficacious. The administration of sulphur in obstinate chronic cases of many diseases often works such a change in the patient's condition as to give potency to other remedies given without effect. As a parasiticide, and especially in skin affections, ring-worm, itch, etc., sulphur ointment is a specific, or at least an active curative agent.

SULPHUR DIOXIDE. See LIQUEFIED AND COMPRESSED GASES.

SULPHUR DYESTUFFS. See COAL-TAR COLORS.

SULPHUR SPRINGS, Tex., city, county-seat of Hopkins County, on the Missouri, Kansas and Texas, and the Saint Louis Southwestern railroads, about 240 miles northeast of Austin, the capital, and 75 miles northeast of Dallas. It is in an agricultural and stock-raising region and has an extensive domestic export trade in cotton products, wheat, corn, fruit (peaches and plums), honey, poultry and livestock. It has two national banks with a combined capital of $200,000. The educational insitutions are the Central College (Methodist Episcopal, South), opened in 1876, and public schools. Pop. about 5,151.

SULPHURETTED HYDROGEN (H_2S), a gaseous compound of hydrogen and sulphur, found abundantly in nature in gases issuing from crevices in volcanic regions, and occasionally in natural gas. It is one of the common products of decomposition of vegetable substances, especially those of the leguminous family. It occurs in illuminating gas, from which it is scrupulously removed at considerable expense. It is prepared on a large scale by heating together equal parts of vaseline or paraffin and sulphur.

Sulphuretted hydrogen is a colorless, inflammable gas, burning with a bluish flame, and having an extremely offensive odor, similar to that of rotten eggs. It is very poisonous; when inhaled in small quantity producing nausea and headache, and in large quantity, asphyxiation. One part of the gas in 200 parts of air is fatal to horses, and one part of gas to 800 of air is fatal to dogs. It is soluble in water in the proportion of 4.4 volumes of gas to 1 volume of water at 32° F. At higher temperatures less of the gas is held in solution. Alcohol at 32° dissolves 17.9 times its own volume.

The aqueous solution of sulphuretted hydrogen is known as hydrosulphuric acid. It smells of the gas, and decomposes on standing, depositing sulphur, and the hydrogen oxidizing into water. Its solution in glycerine, however, keeps good for a long time.

The gas may be liquefied at ordinary temperatures by submitting it to a pressure of 17 atmospheres — that is, about 250 pounds to the square inch. Liquid sulphuretted hydrogen is a colorless, mobile liquid which freezes or soldifies at — 117° F., and boils at — 79°. In its liquid form it is nearly inert chemically.

Sulphuretted hydrogen is used in large

quantities in the manufacture of sulphuric acid to remove the arsenic which is found in larger or smaller percentage in all acid made from pyrites. It is also used to precipitate copper from solutions containing salts of copper, and for precipitating gold and silver from sweepings and other waste material. In the chemist's laboratory it is one of the most valuable reagents.

SULPHURIC ACID, or OIL OF VITRIOL, a common and exceedingly important oxy-acid of sulphur, having the chemical formula H_2SO_4. It was first prepared by Geber, in the 8th century, by distilling alum; and in the 15th century it was manufactured by burning sulphur with saltpetre, though the identity of the product so obtained with that described by Geber was not established until near the end of the 16th century. Considerable quantities of sulphuric acid were formerly manufactured by the distillation of ferrous sulphate, the practice of this method dating from the early part of the 18th century. At the present time practically all of the sulphuric acid that is used is prepared from sulphur dioxide gas, either by the «chamber process,» or by the more recently perfected «contact process,» both of which are described in this article.

When pure and free from water, sulphuric acid is a colorless liquid with an oily appearance, and a specific gravity of 1.89. It may be readily frozen, the solidified acid melting again at 50.9° F. It exhibits the phenomenon of surfusion to a marked extent, and the liquid acid can be cooled, much below the melting point here given, without inducing solidification; but if a crystal of the solid acid, or a small amount of sulphur trioxide, be added to the supercooled fluid, crystallization begins at once, and the temperature rises until it becomes 50.9° F., after which no further solidification occurs. The presence of a trace of water in the acid lowers the freezing point nearly to 32° F. If five parts (by weight) of sulphuric acid be mixed with nearly one part of water, and the solution is cooled by a freezing mixture, a definite hydrate of sulphuric acid, having the composition $H_2SO_4 + H_2O$, crystallizes out at 45° F. Another solid hydrate, having the composition $H_2SO_4 + 4H_2O$, may also be prepared by cooling, to a much lower temperature, a mixture of sulphuric acid and water, containing 57.6 per cent of water. Several other hydrates are also believed to exist, and special study has been expended upon them, on account of their importance in the illustration of the «hydrate» theory of solutions. (Consult Mendeléeff, 'Principles of Chemistry,' Vol. II). Sulphuric acid has no really definite boiling point. It begins to boil at about 550° F., the distillate containing sulphuric acid, water and sulphur trioxide. (See SULPHUR). The temperature of the liquid may be raised to 640° F., however, before a state corresponding in definiteness to the boiling point of water is attained, the vapor that passes off then consisting entirely of water vapor and free sulphur trioxide. At higher temperatures the decomposition is even more complete. Thus if a stream of the acid be allowed to flow over redhot bricks, it is broken up into sulphur dioxide (SO_2), free oxygen and water-vapor. If the gases resulting from this decomposition are passed through cool water, and the steam that they contain is condensed and the sulphur dioxide removed by solution, a supply of pure oxygen gas is obtained. Pure anhydrous sulphuric acid has a specific heat, at ordinary temperatures, of about 0.34, and a coefficient of expansion (Fahrenheit scale) of about 0.000310. The concentrated acid is a powerfully corrosive poison, destroying organic tissues rapidly, and even charring paper and wood. It is also poisonous (though far less violently so) when administered in any considerable quantity in a highly dilute form. Concentrated sulphuric acid has a powerful affinity for water, its combination with water being attended by the evolution of a large amount of heat. The strong acid is used as a drying agent, for removing moisture from gases. For this purpose it is sometimes sufficient to allow the gas to stand for a time in a receiver containing a dish of the concentrated acid; but a more effective mode of procedure consists in passing the gas through tubes that are partially filled with fragments of pumice that have been wetted with the acid.

Chemically, sulphuric acid is dibasic, either or both of its hydrogen atoms being replaceable by metals or other bases, the compounds that are thus formed being termed «sulphates.» With the metals of the alkalis (which are monovalent), sulphuric acid therefore forms two kinds of sulphates, which may be sufficiently illustrated by the potassium salts. If one of the hydrogen atoms of the acid is replaced by potassium, the resulting salt, $HKSO_4$, is called «hydrogen potassium sulphate,» or «acid potassium sulphate»; while if both are replaced, the resulting salt has the formula K_2SO_4, and is known as «normal potassium sulphate.» Many of the sulphates of the metals occur native in large quantities, and many of them are of great value in the arts. Those that are of especial importance are described, in this encyclopedia, under the metals (or other bases) with which the acid is combined. The sulphate of barium is perhaps the most insoluble salt known. It is formed whenever a soluble barium salt (such as the chloride) is added to a solution of a soluble sulphate; and its formation constitutes a valuable test for sulphuric acid and the sulphates. See CHEMICAL ANALYSIS.

When sulphur trioxide is dissolved in anhydrous sulphuric acid in the proportion of one molecule of the trioxide to one of the acid, a definite compound having the formula $H_2S_2O_7$ (or $H_2SO_4.SO_3$) is obtained. When pure, this substance is known as «pyrosulphuric acid.» It is a dibasic acid, forming salts which are termed «pyrosulphates,» but which are of comparatively little practical importance. Pyrosulphuric acid forms large crystals, which melt at 95° F., and it is easily decomposed by heat into ordinary sulphuric acid and free sulphur trioxide. Fuming sulphuric acid (now commonly known in the arts as «oleum» but formerly called «Nordhausen oil of vitriol») consists of a mixture of pyrosulphuric acid and ordinary sulphuric acid and may be regarded as a solution of sulphur trioxide in sulphuric acid, the trioxide not being present in sufficient quantity to convert the ordinary acid entirely into pyrosulphuric acid. It fumes strongly in the air, gives off sulphur trioxide when heated, and is prepared by the «contact process,» described in this article.

The uses of sulphuric acid in chemistry and in the arts are past enumeration; for this acid is one of the most important chemical substances known, and it is employed is so many industrial processes that it has been said that the wealth and prosperity of a nation can be estimated from its consumption of sulphuric acid. About half of the total quantity manufactured in the United States is consumed in the preparation of fertilizers. The two general methods now in use for manufacturing the acid are described in this article.

The sulphur used for the manufacture of sulphuric acid is obtained (1) from the gases generated by burning iron pyrites (FeS_2), (2) from the sulphur deposits of Louisiana, Sicily and elsewhere, and (3) to a very limited extent from the waste gases given off by sulphide smelters. At the present time pyrites is the most important source, but it is probable that smelter gases will be utilized to a greatly increased extent in the future, and they may eventually compete with pyrites. The sulphur dioxide that is now wasted by discharging the fumes from smelters into the air would far more than supply the United States with sulphuric acid. Moreover, the fumes are exceedingly objectionable, and they are destructive to vegetation.

The fundamental principles in the manufacture of sulphuric acid are (1) to oxidize sulphur or a suitable sulphide, so as to obtain sulphur dioxide, SO_2; (2) to further oxidize this to the trioxide, SO_3; and (3) to effect the combination of the trioxide with water, in accordance with the equation $SO_3+H_2O=H_2SO_4$. In attempting to carry out the second of these processes, however, we are confronted by the fact that sulphur dioxide does not readily take up oxygen, so as to become completely converted into the trioxide. To effect this oxidation we are in fact compelled to resort to one or the other of two expedients: (1) To mix a certain amount of an oxide of nitrogen with the sulphur dioxide and air — the oxide of nitrogen then acting as a sort of «carrier», taking up oxygen from the air and passing it on to the sulphur dioxide; or (2) to subject a mixture of air and sulphur dioxide to the action of a suitable catalyzer. The first of these expedients is used in the «chamber process» and the second in the «contact process.»

The first step in the manufacture of sulphuric acid is to provide a suitable supply of sulphur dioxide gas. This is usually obtained by burning sulphur or iron pyrites in a special furnace and considerable skill and judgment are required in this part of the operation, to obtain gases of proper composition. It is also important to minimize the quantity of dust that the gases carry over into the later parts of the process. Settling chambers, baffle plates, centrifugal separators, parallel-plate separators, and filtration through piles of marbles or other loosely aggregated solid lumps are among the devices used for the removal of the dust.

Chamber Process.— In manufacturing sulphuric acid by the so-called «chamber process» the hot gases from the burners (consisting of air, sulphur dioxide and moisture) pass first over «niter pots,» which contain nitrate of soda and sulphuric acid, and which give off the nitric oxide gas that is to act as an oxygen carrier. Then, after passing through the dust-removing apparatus, the gases are passed upward through a tower (technically known as a «Glover tower») that is loosely filled with fragments of coke, pumice, acid-proof stoneware or other inert material to distribute the flow, and here they are met by a downward stream of aqueous sulphuric acid obtained from a later stage of the process and containing oxides of nitrogen in solution. The precise reactions that occur cannot be discussed here, partly because they are complicated, and partly because they are not fully understood. The general effect, however, is to oxidize the SO_2 to SO_3, and the downward-flowing stream of weak acid dissolves the SO_3 and thereby becomes stronger. In certain plants of recent design the oxidation of the sulphur dioxide and the absorption of the resulting trioxide are carried out in a series of Glover towers, without the use of chambers of any sort; but it is usual, after the gases have passed through one or two Glover towers, to cause them to enter large lead-lined chambers (from which the process takes its name), where the oxidation of the dioxide and the consequent strengthening of the acid are continued. Liquid sulphuric acid settles in the bottom of these chambers, and is drawn off from time to time. Steam or water is sprayed into certain of the chambers, as needed, to provide the H_2O that is required for the formation of the H_2SO_4. The gases coming from the last chamber are passed up through a «Gay-Lussac tower,» which resembles the Glover tower in general construction. The liquid that is sent down through this tower, however, is concentrated sulphuric acid, and its purpose is to absorb the nitric oxide gas that is present, thereby preventing its loss and diminishing the quantity of nitre that must be used in the early part of the process. Upon leaving this tower the gases (which then consist mainly of nitrogen and oxygen) enter a stack and pass off into the atmosphere. The acid that is drawn off from the bottom of the final Gay-Lussac tower contains oxides of nitrogen in solution, and is introduced (diluted, as may be necessary, with weaker acid) into the tops of the Glover towers. As the acid passes down through a Glover tower, however, the heat due to the reactions that occur, added to that which the entering gases already possess, drives off the nitrous oxides, and these keep returning upward through the tower with the sulphur oxides and air, while acid nearly free from nitrous oxides comes away from the bottom of the tower.

Sulphuric acid, as made by the chamber process (and especially when made from pyrites) is likely to be contaminated with lead, arsenic, nitrous oxides and many other substances. Certain of these may be removed in considerable measure by treatment with sulphuretted hydrogen. If an acid of high purity is required, however, it is better to make it by the contact process, presently to be described. When treated with sulphuretted hydrogen for the removal of impurities, the acid should not have a greater specific gravity than 1.4, corresponding to about 50 per cent of actual H_2SO_4, and must be diluted to this strength if it is already stronger. After the removal of the arsenic the purified acid is concentrated by evaporation if a strong product is required. The evaporation may be carried out in leaden pans, but a better product is obtained by effecting the concentration in platinum stills. Owing to the high cost of platinum, however, it is common to perform the evaporation in a series of evaporating dishes constructed of fused silica. These are arranged like a flight of steps, the lip of each one projecting out over the next dish. below. A slow stream of acid is kept running down through the cascades of dishes, while heat is applied to each dish from below. When an apparatus of this kind is properly arranged and operated it gives excellent results. Hoods should be arranged over the dishes, however, to take up the vapors that are given off and dispose of them in some proper way.

The Contact Process.— In the contact process for the manufacture of sulphuric acid, the sulphur dioxide is caused to combine with the oxygen of the air by bringing the mixed gases into contact with finely divided platinum, or with platinized asbestos. The catalytic action of platinum (that is, its power of inducing combination in this way, without being itself consumed or otherwise permanently affected) was discovered by Sir Humphrey Davy, in 1818; and in 1824 Doebereiner showed that finely divided platinum can effect the ignition of a jet of hydrogen, when this gas impinges upon it in contact with air. Peregrine Phillips, of Bristol, England, first produced sulphur trioxide by utilizing the catalytic effect of finely divided platinum upon a mixture of oxygen and sulphur dioxide, taking out a patent for this process in 1831; and Schneider, in 1848, made a working model of an apparatus for manufacturing sulphuric acid by this method. Since that time many attempts have been made to make the contact process practicable for the manufacture of sulphuric acid, and many other catalytic agents have been tried besides platinum. It was not until about 1898, however, that the various practical difficulties involved in the process were satisfactorily overcome, largely through the labors of Herr Knietsch of the Badische Anilin und Soda-Fabrik, a German company for the manufacture of chemical substances of nearly every kind. It was found that the prime condition of success in the application of the contact method is that the gases that are treated shall be absolutely free from dust, arsenic, mercury and certain other substances. The gases from the pyrites-roaster are cooled very slowly and are then purified by filtration and washing. When passed to the tubes containing the platinized asbestos that is used as the catalytic agent, 100 volumes of the roaster-gas contain 7 volumes of sulphur dioxide, 10 volumes of oxygen and 83 volumes of nitrogen (from the air). The catalytic platinum is maintained at a temperature of about 750° F., since it is found that at this temperature the production of sulphur trioxide is about 98 per cent of the theoretical production. The nitrogen that is present has no influence upon the reaction, when the apparatus is working properly. The sulphur trioxide that is produced by this method needs only to be dissolved in previously prepared sulphuric acid containing more or less water, in order to yield an acid that is quite pure. It might naturally be supposed that water would be the best absorbent for the trioxide; but it is found that an acid that contains from 97 to 99 per cent of H_2SO_4 is a better absorbent; and in the practical conduct of the process the trioxide is absorbed by an acid of this strength; the stronger acid that its solution yields being continuously drawn off and continuously replaced by fresh supplies of the 97 to 99 per cent acid, except when fuming acid of a very high degree of concentration is wanted. The minute details of the contact process are trade secrets and are carefully guarded.

The standard work on sulphuric acid manufacture is Lunge's 'Sulphuric Acid and Alkali.' Very good general accounts will be found, however, in Rogers' 'Manual of Industrial Chemistry' and Thorp's 'Outlines of Industrial Chemistry.'

Allan D. Risteen.

SULPHURIC ETHER. See Ether.

SULPHUROUS ACID, an acid having (probably) the formula H_2SO_3, and prepared by dissolving sulphur dioxide gas (see Sulphur) in water to saturation; the acid being formed by the union of one molecule of the dioxide with one molcule of water, according to the equation $SO_2 + H_2O = H_2SO_3$. Sulphurous acid has never been isolated, and is known only in its aqueous solution, in combination with bases in the form of the salts known as "sulphites," and as a solid hydrate. At 70° F. water dissolves about 35 times its own volume of sulphur dioxide; the solubility being greater at lower temperatures, and less at higher ones. When an aqueous solution of sulphurous acid is cooled below 41° F., a crystalline hydrate of the acid separates out, the composition of which is not definitely known. Sulphurous acid has the taste and smell of sulphur dioxide gas, and is strongly acid. It readily gives off sulphur dioxide gas, and upon standing in contact with the air it gradually absorbs oxygen and becomes converted into sulphuric acid. Its composition is also modified by the action of light, probably by the formation of a more complex oxy-acid of sulphur. It acts as a dibasic acid, combining with the oxides, hydrates and carbonates of many of the metals to form salts (that is, sulphites) which are readily decomposed by the addition of stronger acids, with the liberation of sulphur dioxide. It is used in the bleaching of silk and wool but not so much as formerly, having been largely displaced by hydrogen peroxide. When the hydrogen atoms of the acid are both replaced by a metallic base, the resulting salt is called a "normal sulphite"; and when only half of the hydrogen of the acid is so replaced, the salt is called an "acid sulphite," or a "bisulphite." Both of the sulphites of sodium are extensively used in photography; the normal sulphite having the formula $Na_2SO_3 7H_2O$, and the acid sulphite the formula $HNaSO_3$. (See Photography). Industrially, the bisulphites of calcium and of magnesium are of exceeding importance, since the aqueous solutions of these substances possess the power of dissolving the gummy matters by which the fibres of certain kinds of wood are cemented together. Upon this property, the "sulphite process" for the manufacture of wood pulp is based. (See PAPER). Calcium sulphite is also used in the brewing industry.

SULPICIANS, sŭl-pĭsh'ĭ-ạnz. See ORDERS, RELIGIOUS.

SULPICIUS SEVERUS, sul-pĭsh'ĭ-ŭs sĕ-vē'rŭs, Roman ecclesiastical writer: b. Aquitania, 363 A.D.; d. Marseilles, between 410 and 429. He was from a family of high rank and in the practice of the law at Toulouse attained a great reputation for learning and eloquence and led a gay though charitable life. The death of his wife led him to more serious pursuits. Having entered a monastery, he spent some years in preparing an abridgment of the scriptural narrative, which from the purity of its style was long a favorite textbook in the schools of the Middle Ages, but is liable to the charge of serious tampering with the facts, arising in part probably from the desire to rebuke in this guise some contemporary rulers. He continued this history, describing the destruction of Jerusalem and bringing the narrative down to his own time, under the title of 'The Chronicle of Sulpicius Severus,' in which he varies materially from Josephus. His other works are 'Life of Saint Martin, Bishop of Tours'; 'Three Dialogues' and a collection of letters. From the elegance of his Latinity he was called, not undeservedly, "the Christian Sallust." His works have been often printed.

SULTAN, *in Arabic,* signifies monarch, ruler. The title is borne by various Mohammedan rulers, while the Turkish emperor assumes the title of Sultan-es-selatin, 'Sultan of sultans.' The daughters of the sultan have also the title of sultan. The title of sultana is given out of Turkey to the chief concubines of the sultan, but no such title is in use for them in Turkey. If the mother of the sultan is living she is styled *sultan Valide.*

SULU, soo-loo', or **JOLO,** hō-lō', Philippines. (1) An archipelago, consisting of over 400 islands, forming the southern central portion of the Philippine Archipelago, lying between the parallels 4° 30' and 121° 52' N. lat. and the meridians 119° 25' and 121° 52' E. long.; area 1,029 square miles. The archipelago is surrounded by the Sulu and Mindanao seas on the north and west and the Celebes Sea on the south and east. The islands form a long chain extending from northeast to southwest and are divided into five principal groups: (1) Balanguingui; (2) Pañgutárang; (3) Sulu; (4) Tapul; (5) Tawi Tawi. The larger islands are generally high and of volcanic formation; the smaller islands are low and rest on coral; mountain chains traverse the islands of Sulu and Tawi Tawi. The larger islands are fertile; rice, coffee, chocolate, corn, hemp, saffron, indigo, sesame and cotton are cultivated, but not as a rule for export. The raising of horses, cattle and goats is an important industry; there is some metal working in the manufacture of chisels, knives, etc., and weaving for home consumption. The chief industry from the commercial standpoint is pearl and pearl shell fishing, large quantities of pearl shell especially being exported; other exports are shark's fins, beche de mer and native cordage. The trade is largely in the hands of the Chinese. The forests contain many of the most valuable woods of the East. The people of the archipelago are divided into four groups, according to their origin and customs: (a) The Guimbajanos, the aborigines living in the mountains; (b) the Malay and Visayan slaves; (c) the Samales; (d) the Moros proper, the dominating race. Mohammedanism is the prevailing religion; polygamy and slavery are recognized institutions. Piracy was formerly a regular occupation of the people and their depredations were carried as far as Singapore. (See MOROS). Spain never occupied but a few towns on the coast and the native government remained largely independent of Spanish dominion. When the islands were transferred to the United States, after the Spanish-American War, negotiations were immediately begun for establishing satisfactory relations between the United States government and the sultan of Sulu and his datos (or chiefs). In August 1899 a treaty was signed in accordance with which the sovereignty of the United States over the whole archipelagó was recognized, but the government of the sultan and datos continued under this supreme jurisdiction, the rights and religion of the Moros to be respected, with the following important stipulations: the United States shall occupy and control such parts of the archipelago as public interest demands; any person can purchase land with the sultan's consent; piracy shall be suppressed; American courts shall have jurisdiction except between Moros; the American government shall protect the island against foreign aggression. Pop. (estimated) 22,680. (2) A group of islands in the central part of the Sulu Archipelago, lying between the Balanguingui group on the north and the Tapul group on the south; area 380 square miles. All of the larger islands of this group are volcanic, each of them being formed of a central peak sloping to a narrow stretch of level coast land; the islets are generally rocks. All the staples of the archipelago are cultivated; a small amount of hemp and indigo is exported; but cattle raising and fishing occupy a larger number of the inhabitants. The trade between islands is by native craft; the port of export is the town of Sulu. Pop. 14,500. (3) An island, the central and largest one of the Sulu group; area 333 square miles. It is traversed from northeast to southwest by three nearly parallel mountain chains, between which lie fertile valleys; there are several important peaks, of which the highest has an elevation of 2,894 feet. There are numerous small streams; which are nearly or completely dry during the summer season. The climate is particularly good, the temperature being even and unusually cool for the latitude. The soil is fertile and is well cultivated; rice, however, is imported and the chief articles of export, as in the rest of the Sulu Archipelago, are the products of the fisheries. The mountains are heavily wooded and valuable cabinet woods are also among the exports. Under the American jurisdiction, a school has been established on the island. (4) A town, capital of the Sulu Archipelago, situated on the northwest coast of Sulu Island, 540 miles south of Manila. It was the ancient residence of the Sulu sultans, but scarcely a trace of the ancient Moro town remains; the present town was built in 1878 by the Spaniards. It is surrounded by a wall, within which the town is regularly laid out, with three principal streets, broad and well shaded. The houses are mostly well built and there is a large modern market house. It is the chief town and chief port of the Sulu Archipelago and carries on a large trade with Singapore and Manila, as well as a native inter-island trade. In the channel between the roadstead and Maroñgas is a pearl oyster bed, which employs a large number of fishing boats and the town is the centre of this industry.

SULZBERGER, sŭlz'bĕr-jĕr, **Mayer,** German-American jurist: b. Heidelsheim, Germany, 22 June 1843. During the Revolution of 1848 his father came to America with his wife and family, settling in Philadelphia in 1849. He received his early education at the public schools where he graduated in 1859 from the Central High School, being at the same time an apt pupil at home in Hebrew language and literature. On 16 Sept. 1865 he was admitted to the bar, where his career was brilliant and his commanding abilities received their recognition on his appointment as judge of the Court of Common Pleas (1895–1915), and presiding judge (1902–15). Judge Sulsberger edited *The Occident* for a year after its founder's death, was tendered the position of United States Minister to Turkey during President Harrison's administration but declined the honor, is prominently identified with Jewish charities and instructions, and is a trustee of the Baron de Hirsch Fund. He is the author of 'Am ha-Aretz' (the ancient Hebrew Parliament) (1909); 'The Polity of the Ancient Hebrews' (1912); 'The Ancient Hebrew Law of Homicide' (1915).

SUMAC, any shrub or tree of the genus *Rhus*. Some species are poisonous to the touch. (See PLANTS, POISONOUS). One of the most common innocent eastern species of America, and the largest, is *Rhus hirta*, the staghorn sumac, so called because its young, short branches are covered with down, in color and texture not unlike a deer's antlers «in the velvet.» The trees are not more than 30 feet high, but are apt to grow in clumps and have a tropical appearance, with their long pinnate leaves turning to vivid yellow and crimson in autumn. Their autumnal beauty is further enhanced by the torch-like panicles of fruits, small drupes matted together by the crimson plush of the hairs that cover them in to pyramidal bunches terminating the branches. These fruit-masses remain throughout the winter, and are a favorite food of chickadees, in spite of the fur and the acidulous taste. The sour flavor was taken advantage of by the Indians and colonists who made a cooling drink from the plant. The crimson hairs also yielded a red dye, when immersed in boiling water. The wood is yellow and handsomely veined, but is very brittle; it is, however, occasionally made into canes. The fragrant, or sweet-scented sumac (*Rhus crenata*), is a low shurb with aromatic leaves and large panicles of greenish, honey-scented flowers which bloom in spring and are a famous food for bees. *R. glabra* is the upland or smooth sumac, which is smooth and even glaucous; its leaves were added to the tobacco of the aborigines; and an efficient gargle is made from the refrigerant and astringent drupes. The dwarf black or mountain sumac (*R. copallina*), similar in size to the above species, and like them having panicles of bloom succeeded by scarlet masses of drupes, is more bushy in growth, forming low thickets in sandy or dry, almost sterile soil, and is peculiar in that the main stem of its compound leaves bears coriaceous wings between the leaflets. The latter are shining above, and pubescent beneath, and, like those of *R. glabra*, when dried are material for tanning. They are, however, said to be inferior to those of the *Rhus coriaria*, native to and cultivated in the Mediterranean regions, which are especially valuable for tanning fine leathers, as the light-tinted moroccos. They are collected, dried, and exported in great quantities in the shape of a fine dust. The Venetian sumac, or smoke-tree, is also used for the same purpose. (See SMOKE-TREE). The sumacs are very useful tree shrubs to the Indians of the western United States. The twigs of *Rhus trilobata*, the aromatic sumac, having small three-lobed leaves, are soaked, scraped and split, resoaked in water, and then woven into baskets., sometimes in conjunction with other materials. These light, straw-colored withes are used probably more than any material except the willows for native basketry. *R. diversiloba*, the poison-oak, although greatly dreaded by the Cherokees, who endeavor to conciliate it by addressing it as «my friend,» does not seem to injure certain Californian tribes so much. They even use it as medicine, sometimes poisoning themselves internally by the practice, and use twigs of it as water-sprinklers in sacred ceremonies; it is also a material for woven fabrics. Its juice, which turns black rapidly on exposure to air, is utilized as an intense black dye for basketry. *R. trilobata* likewise yields a dye. A strong decoction of the leaves and twigs is made, to which is added roasted pinyon gum and yellow ochre, forming a rich, blue-black fluid, which is practically an ink, the tannic acid of the sumac combining with the iron in the yellow ochre, and being strengthened with the carbon of the burnt gum. The lacquer or varnish of China and Japan is nothing but the sap of another sumac (*R. vernicifera*) or varnish-tree, cultivated in those countries. When the bark is cut, the shrub exudes a juice, darkening after exposure. When kept for some time this sap becomes thick and viscous, blackish-brown in color in one mass, but yellow-brown and transparent in thin layers. When properly applied in successive layers and dried, it becomes a natural varnish of great hardness and unalterability. Nut galls, or iron in solution, added to this, or gold and other metals, make the various kinds of lacquer or japanning, which it often takes years to perfect. Japan wax is a vegetable wax used chiefly for candles and obtained by crushing, steaming and pressing the drupes of this species and of the Asiatic *R. succedanea*.

SUMATRA, soo-mä'trạ, an island in the Indian Seas immediately under the equator. Its extreme limits are lat. 5° 45′ N., and 5° 55′ S.; long. 90° 40′ E., and 106° 5′ E. In the direction of its greatest length it extends from northwest to southeast. Its greatest length is about 1,000 miles, and its greatest breadth about 260 miles; its area is about 161,600 square miles. It ranks in magnitude as the second of the

Asiatic islands, Borneo being the first. The population is about 4,000,000.

Topography.— The west side of the island is mountainous, but the east side has a totally different character, and spreads out into interminable plains nearly as level as the sea. The mountains viewed from the west appear at first view to form a continuous ridge, but a closer examination reveals breaks in the chain, and discloses the fact that two or three ridges lie behind that which is mainly seen from the coast. This chain, known generally as Barisan, extends from the northwest of the island to Sunda Strait. The islands of Pulo Bras and Pulo Wai really form detached parts of it, and near them, at the northwestern end of the island, it attains a height of 5,663 feet in Mount Yamura. Farther south, but still in Achinese territory, are the lofty volcanoes Abong-Abong and Lusé, whose heights are estimated at over 11,000 and 12,000 feet respectively. Mount Ophir, close to the equator, is an extinct volcano 9,610 feet above sea-level. Not far to the south is Mount Merapi, one of the most violent of Sumatran volcanoes. Other notable peaks are: Talang (8,343), an extinct volcano, from which the natives obtain sulphur; Indrapura (12,000), the highest peak yet ascended in Sumatra; Mount Paung; Mount Kaba (5,413); Mount Dempo (10,562), an active volcano; and Mount Tangkamus (7,422), near the Straits of Sunda. Granite, slates, clay-schists and similar rocks abound, and limestones of Carboniferous age occupy much of the surface. The Tertiary formations cover a very large area. All the peaks seem to be volcanic. Various metals have been found in the island, and excellent coal is known to be abundant.

Rivers and Lakes.— The rivers that flow toward the west are naturally short and of small importance for navigation, but those traversing the broad alluvial eastern slopes are long and deep. Many of them form large deltas. In order from south to north the most important are: the Musi or Palembang, about 400 miles long, passing the town of Palembang and entering the sea opposite the island of Banka, an important highway for trade; the Jambi or Batang-Hari, over 500 miles long, and navigable throughout most of its length, important as an outlet for the chief coal-fields; the Indragiri; the Kampar; the Siak, rising near Mount Ophir; the Rakan and the Batu Bara. Of the west-coast rivers the Singkel is the most important. The lakes of Sumatra are mostly mountain lakes, and not a few of them occupy the craters of extinct volcanoes. The largest are: Toba, 500 square miles in area, at the source of the Singkel River; Singkara and Maringin, about the centre of the island near the west coast; Korinchi, near Indrapura; and Danau. Sumatra is almost bisected by the equator, and in consequence the monsoons of its northern extremity have different directions from those of the southern end. During the periods when the monsoon is changing, navigation in the neighboring waters is impeded by squalls. The climate is generally of the usual tropical character, and is on the whole rather unhealthy.

Flora and Fauna.— The flora of Sumatra differs much from that of Java. It is very rich in forest trees, many of which yield valuable timber or other useful products, such as benzoin and gutta-percha. Pepper is the chief cultivated product. Sago and rice are also cultivated, and excellent tobacco and coffee are grown for export. The fauna of Sumatra in some respects resembles that of Borneo more closely than that of the countries with which it is almost in contact. The elephant and the tapir, frequent in Sumatra, are unknown in Java. The former island has the two-horned, the latter a single-horned rhinoceros. The orang-utan is found locally. The tiger occurs both in Sumatra and Java, but not in Borneo; Sumatra has also some species of deer and antelope, the sunbear, a peculiar kind of hare, and the muntjac. The most notable birds are the Argus pheasant, several trogons, bush-shrikes, rain-birds, pheasant-cuckoos, etc. Of the domesticated animals the most important by far is the pig, next to which rank the cow and the horse. The buffalo is more frequent in the low country, but is only valued as food, and never yoked for labor as in Java. The horse of the highlands is small, but vigorous and capable of enduring much fatigue.

Government.— The authority of the Dutch extends, nominally at least, over the greater part of the island, and may be considered to be real over all the coast districts. In the interior, however, there are still considerable tracts under native rulers, or forming village confederations, over which the Dutch exercise little or no authority. The Dutch possessions are divided into six chief divisions. The government of the west coast, with an area calculated at 31,649 square miles, extends along the middle portion of the west coast, and includes Padang and other districts. The governor resides at Padang. The residency of Benkulen lies to the south of that of the west coast, and has an area of 9,399 square miles, Benkulen being the capital. The residency of Lampong comprises the southern districts of the island on the Strait of Sunda, and has an area of 11,284 square miles. The residency of Palembang on the east coast, with an area of 53,497 square miles, lies to the north of Lampong, and has as its capital the large town of Palembang. The district of Indragiri, farther north, belongs to the residency of Riou, which is named after the island of that name. Farther north is the residency of the east coast, its area being estimated at 35,312 square miles; and at the extreme northwest that of Achin, which still remains semi-independent, area 20,471 square miles.

Racial Characteristics.— Sumatra is inhabited by a very mixed population. Malays collected from every quarter of the archipelago inhabit the coast. Hindus appear to have settled at an early age in the north, and to have modified the Malay type of the Achinese. The Arabs in the island, though few in number, have always formed an important class. Chinese are numerous, particularly on the east coast. Northwest of Palembang the Orang-Kubu live in a savage state, and shun any intercourse with the neighboring tribes. The Orang-Kubu must not be confounded with the people of Menankabu, a pure Malay race inhabiting the highlands of Padang, which some are disposed to consider the original seat of the Malay stock. The Battaks are a peculiar and interesting race. Like the Malays they are of short stature, but they differ from the former in being strongly built and well proportioned. The art of writing has been known among the Battaks from a date beyond the reach of tradition. Their characters are peculiar, and also their mode of writing, for they begin at the bottom of the page at the left-hand side, and place letter above letter in a vertical column till they reach the top, when they return to the bottom. Their ancient books are written in a brilliant ink on paper made of the bark of trees, but now they scratch their writings on slips of flattened bamboo. Among all the indigenous tribes of Sumatra the characteristic political tendency is one that could have originated only in the recesses of the mountains. Every village affects independence, but the villages form confederations. The native tribes of Sumatra have no temples and no priests. They are said to believe in the existence of an evil spirit and of demons who haunt the mountains. On the coasts Buddhism appears to have been introduced at an early age, but it has since been completely superseded by Mohammedanism, which, among the Malays, however, is of a very relaxed character.

History.— The first European who visited the island of Sumatra is said to have been Niccolo di Conti, who came there before 1449. In the beginning of the 16th century it was visited by the Portuguese, but no Europeans obtained a firm footing on the island until the Dutch established a factory on the west coast at the end of the 16th century. In 1666 the Dutch took possession of Padang, and soon after enlarged their territories by treaty with the Sultan of Achin. Since that time they have gone on continually consolidating and increasing their dominion much more by negotiation than by force of arms. Their last important accession of influence on the island was gained by a treaty with the kingdom of Siak, concluded in 1868, by which they obtained the virtual control of that state. In 1685 the British formed a settlement in Benkulen, and in 1811 they seized the Dutch possessions on the island. These were, however, restored in 1815, and in 1824 Benkulen was given over to the Dutch in exchange for Malacca. A treaty concluded between the Dutch and English governments in 1834 left the Dutch free to make what treaties they pleased with the native powers in the island of Sumatra, the same liberty being allowed to the British on the Malay Peninsula; but the right of the Dutch to make advances in the island by conquest and annexation was not then recognized. This right was, however, conceded in the treaty of February 1871, in return for the cession to the British of the Dutch possessions on the Gold Coast; and in accordance with this permission the Dutch despatched an expedition against Achin. In April 1873, the forces of the two powers came into collision, and a war ensued which dragged on for a number of years, caused severe losses to the Dutch, and terminated only in the nominal subjugation of Achin. In August 1883 the tidal wave that accompanied the terrific volcanic outburst in Krakatoa, swept with destructive effect the south coast of Sumatra, a total change in the aspect of the Straits of Sunda also resulting from the eruption. Consult Bernard, 'A travers Sumatra' (Paris 1910); Breitenstein, H., 'Sumatra' (Leipzig 1902); Cabaton, A., 'Java, Sumatra and the other Islands of the Dutch East Indies' (New York 1914).

SUMBAWA, soom-bä'wä, an island belonging to the Sunda group, in the Indian Ocean, east of Java, containing 5,192 square miles. The island is mountainous and of extraordinary profile. The volcano of Tomboro or Tombura, 8,940 feet high, is near the northern coast and famous for its eruptions. The island consists of two parts, with two rulers or sultans, who acknowledge the sovereignty of Holland. There are few streams. The chief products are rice, cotton, tobacco, tropical fruits and sappan-wood. Of domestic animals deer and swine are plentiful, and the finest horses of the Indian Archipelago are reared here, and exported. Edible birds' nests are found on the coasts; gold, silver, saltpetre and pearls from the mines and waters, respectively. On the north coast there is a good harbor, and here stands the town of Sumbawa. The inhabitants are Malays and Mohammedans. Pop. 75,000.

SUMBUL, an East Indian name of the spikenard (*Mardostachys*), and also of the valerian, but, more particularly of *Ferula sumbul*, the commercial drug also known as musk-root. The last is an umbelliferous plant, with dissected leaves. The roots reach the pharmacists in transverse segments, light and spongy in texture, with a thin, brown, wrinkled and fibrous skin, but whitish inside. The taste is bitter and balsamic, the odor strong and like musk. Sumbul is used therapeutically as a stimulant and nervine, and was of importance long before its botanical history was known.

SUMERIAN LANGUAGES. The pristine, agglutinous language spoken by the earliest, prehistoric people of Mesopotamia, a region generally referred to in surviving documents as *mat Shumeri u Akkadi*, i.e., land of the Sumerians and Akkadians, probably the biblical Shinar or Shin'aar. It was a non-Semitic people thus dwelling in the lowlands between the Euphrates and Tigris, as comparative philology has of recent years proved beyond a doubt. True, the eminent French scientist, Joseph Halévy, in 1876, and certain of his followers, contended for the non-existence of any such early non-Semitic population. Halévy attempted to account for the early Sumerian documents in cuneiform characters by assuming a Semitic, priestly, secret style of writing, a cryptography, and cited as a parallel the Egyptian hierarchical writing. However, this has since been amply disproved. The meaning of the word Sumerian, or rather Shumerian, refers to the word «reed,» «reedy» in that idiom, evidently because of the marshy, reedy landscape. The Sumerians and the Akkadians seem to have formed one people, though originally they may have come from different parts of the earth. The Sumerians, at any rate, as their tongue, an agglutinous one, shows, must have come from the north, possibly the Ural region, as there were no words or word pictures and phrases in it symbolizing fauna and flora of the subtropics.

So far as the records go, the Sumerians were the earliest nation, and their system of writing, the cuneiform, is likewise the earliest we know of. Later on, the Sumerians, by cohabitation and intermarriage, were gradually amalgamated with the later Semitic invaders, Arab tribes originally coming chiefly from the island of Bahrin. The Sumerian tongue likewise coalesced in a manner with the Semitic idiom, the latter being superimposed on the former, much as the Norman French was superimposed on Anglo-Saxon, and thus the later Babylonian was formed. Sumerian civilization and language, however, were highly developed before the coming of the Semites, as well in the construction of the latter as in its religion, its religious observances, its legislation, arts, science and social life. The Semitic Babylonians imbibed the earlier civilization.

Nevertheless, the «Sumerian problem,» so-called, had for generations perplexed Assyriologists. Oppert, in 1854, first made modest, though in a measure successful attempts to unravel its mysteries. But Prof. Paul Haupt, assisted by Profs. Peter Jensen and Zimmern, somewhat profiting by these initial labors, steadily hewed his way through these etymological brambles, and it is strikingly illustrative of the value of Haupt's pathbreaking labors that all subsequent phonetic and grammatical work in Sumerian has only tended to confirm Haupt's views in almost every instance. Haupt's «Sumerian Family Laws» and «Akkadian and Sumerian Cuneiform Texts» laid the foundation to all later researches. In the investigation of the Sumerian idiom no comparison should be made between Sumerian vocables and those of more recent agglutinous idioms, despite frequent tempting resemblances, such as in Turkish, for instance. Now and then, though, certain similarities are traceable with Esthonian and Finnish. Sumerian, as far as has been shown up to the present, must be held a language standing alone by itself, a «prehistoric philological remnant.»

To Prof. Friedrich Delitzsch is due the merit of having clearly shown the full meaning, the derivation and development of Babylonian cuneiform signs. They were, then, at first pure picture writing and finally grew into conventionalized ideographic and syllabic sign lists. The etymological labor involved in this process of gradual elucidation was surrounded with enormous difficulties.

Sumerian cuneiform was adopted at least about B.C. 7000. By B.C. 5000 we see it already highly specialized, and between B.C. 4000 and 3000 we perceive it applied to the transmission of the invading Semitic language, the Babylonian; and since then the Semitic Assyrians, the Medes, the Turanian Susites, and the Caucasian Armenians have all habitually used the cuneiform.

Besides other evidence tending in the same direction, perhaps the most convincing proof, from a philological point of view, that ancient Sumerian was a real idiom, of natural growth and wholly unartificial, may be found, aside from the internal phonetic changes, in the indubitably established fact that there were two dialects of it. These were the *Emeku*, the man's language, the noble, virile, though harsh form, and the *Emesal*, the woman's language, the softer. There were no geographical boundaries to these two dialects. In R. E. Brünnow's «A Classified List of all Simple and Compound Ideographs» (1889), it is also demonstrated that the Sumerian original idiom was of unaided growth. He and others point out that there were probably eight voice tones employed in Sumerian, similar to the Chinese of to-day, and that the intonation often determined the meaning. As a possible illustration may be cited: *a* = water, weep, moisture, dew, tears, inundation, irrigation; *ab* = dwelling, sea, road, and a grammatical suffix.

After Sumerian had ceased to be a living tongue it was, up to a very late period of Babylonia's existence, greatly used as a ritual one, and was read aloud at worship in the temples, much as is, for example, early Slavonic in Russian and other Orthodox churches to-day.

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WOLF VON SCHIERBRAND,
Author of 'America, Asia and the Pacific,' etc.

SUMMARY COURT. See LAW, MILITARY.

SUMMARY PROCEEDING, *in law,* a form of trial in which the ancient established course of legal proceedings is disregarded, especially in the matter of trial by jury. In no case can a party be tried summarily unless when such proceedings are authorized by legislative authority, as in a committal for contempt of court, the conviction of a person by justices of the peace, etc.

SUMMER, the season of the year which in the northern hemisphere generally may be said to comprise the months of June, July and August. The astronomical summer lasts in the northern hemisphere from the June solstice to the September equinox, during which time the sun, being north of the equator, shines more directly upon this part of the earth, and rises much sooner and sets later, which renders this the hottest period of the year. The period of greatest heat generally takes place in August, since the influence of the sun's rays has then been felt for a long time on the earth, and the wind blowing from the north becomes milder owing to a moderation of the temperature in the polar circle caused by the thawing of the ice. In the southern hemisphere the summer lasts from the December solstice to the March equinox.

SUMMER DUCK. See WOOD-DUCK.

SUMMER REDBIRD. See TANAGER.

SUMMER SCHOOL OF THE SOUTH, a school for teachers established at the University of Tennessee, Knoxville, in the summer of 1902. It was organized to supply the ever-increasing demand on the part of southern teachers for a summer school of high grade and adequate equipment for the best normal training. It receives its financial support from the General Education Board, from the University of Tennessee, from the citizens of Knox County, and from individual donations; the registration fee is small. All the buildings and full equipment of the university are given to the use of the school. The courses number over 150. The work is arranged in the following groups: (1) Common school subjects and methods, including kindergarten and primary grades; (2) psychology and pedagogy; (3) high school and college subjects; (4) rural schools and county supervision; (5) city school supervision; (6) general lectures; (7) library work and educational exhibits; (8) campaigners' conventions. Teachers have free choice of subjects, but are advised not to take work for more than three or four periods a day. The instructors and lecturers are men and women of recognized scholarship and authority, coming from various institutions and different sections of the country. The school has a large attendance and has proved a marked success.

SUMMER SESSIONS. The summer school responds to a specific need. Professional people such as teachers, ministers, doctors and also other workers like social workers, Y. M. C. A. and Y. W. C. A. secretaries and even business men and women, find the summer vacation period a suitable time to undertake advanced educational work in specially selected subjects. The other seasons of the year are devoted to exhaustive labors; the summer study is both recreative and inspirational and may be made to contribute to professional advancement. When systematically planned and extended over a period of years, such summer work may even have recognition in the form of academic credit or academic degrees.

Of the persons listed above teachers in service make the most insistent demand for summer courses. New methods and new educational movements continually call for special short courses. For example, the Montessori method, or the Direct Method in Latin, may be studied to advantage in this way. Teachers may add to their regular accomplishments certain special, perhaps new, activities, such as domestic science and art, various phases of handwork, craftswork, physical education, elocution, etc. Again, a famous teacher from a foreign land may offer courses during a summer session, affording attractive opportunity for special investigation, or for getting a particular method or a particular form of interpretation in a known field. It is a growing practice among municipal school authorities to offer special inducement to public school teachers to take summer courses. The elementary teacher more particularly, but the high school teacher also to some extent is tempted to stagnate. After teaching the same subject several years, the dull monotony of the process deadens the ambition. This is especially true where knowledge of method is more important than knowledge of subject matter as in the elementary school. The opportunity for summer study is especially inspiring in such cases.

Physicians also find it desirable to investigate new treatments, to observe and learn new methods in surgery, to get a new point of view in the profession. The summer session or clinic may give the desired opportunity. Even the farmer demands special opportunities for the observation of special methods and practices and looks to a short session of the Agricultural College to supply his needs. In this case, however, the winter may offer greater advantages.

Recently efficiency experts have advocated the continuous use of educational plants. The idle recitation halls, laboratories and libraries are considered uneconomical. This idleness may continue from 15 June to 15 September, 25 per cent of the educational year. Apparently this records only 75 per cent efficiency for faculties, plants and investments. For the faculty the inefficiency is only apparent since the fallow months are essential to the later increase in fertility and resourcefulness. Of the plant, however, and of the invested funds, the charge of inefficiency is partly true. If a separate faculty can be provided to use the equipment during the summer, a faculty that has its fallow months at another season of the year, then an all year program becomes efficient.

The Four-Term Year.—A continuous session plan was devised at Chicago University by President William Rainey Harper, when that institution was first opened in 1892. It provides (1) four terms of twelve weeks each; (2) twelve terms completed work are required for graduation; (3) that a student may complete twelve terms in three years; (4) that a student may select any three terms as a year's work, devoting the other term to rest or business; (5) that a member of the faculty may elect to be absent from college duties during any one term of any calendar year.

This plan accomplishes all that summer sessions usually seek to do and much more. (1) It incorporates the summer session as an integral part of the academic year. The summer term differs in no essential respect from any of the other terms. (2) Students may begin their college or university courses four times each year. (3) The university equipment is in continual use. (4) The university can use the best men from other institutions in this country and even from foreign universities.

The continuous session plan or the four-term year is the logical development of the summer school movement. Its sponsor, Chicago University, has used it continuously from 1892 to 1918. A quarter of a century has tested the plan thoroughly and has justified it. That few other colleges and universities have adopted it is no argument against it. It seems probable that acquaintance with its features and its satisfactory results will gradually lead to a wide if not universal use of it.

History of Summer Schools.— The Concord School of Philosophy was proposed by Ralph Waldo Emerson as early as 1840 and came to full fruition between 1879–85. The Harvard Summer School has lived from 1869 to the present. The Chautauqua Summer School began in 1874. A summer school of law was opened in 1870 by the University of Virginia. From these beginnings have grown innumerable schools. Not only do most of the colleges and universities conduct such schools but Chautauqua schools, Y. M. C. A. and Y. W. C. A. schools, music schools, tutoring schools, normal schools, library schools, etc., are meeting the growing demand for summer school facilities. According to the latest report (1916) of the United States Bureau of Education 674 schools were in session during the summer of 1915, 47 universities, 40 colleges, 90 normal schools, 39 other institutions, 458 independent schools.

All colleges and universities listed offer academic credit for work completed in the summer session. Of 90 normal schools listed, only 48 offer credit. The basis for such credit is 30 hours of recitations, implying 60 hours of preparation for each credit-hour. A student may usually earn four credit-hours in one summer session. Since a college year is given 15 credit-hours, it will require four summer sessions to earn a full credit-year.

The process is, therefore, slow, but thousands of students persist until they earn the coveted credit-year. Especially is this true of students whose college course was interrupted and who in this way complete work for the bachelor's degree; and many college graduates take this means of earning a master's degree.

A. R. Brubacher,
President of State College for Teachers, Albany, N. Y.

SUMMERS, George William: b. Fairfax County, Va., 4 March 1807; d. Charleston, W. Va., 18 Sept. 1868. He entered Ohio University at Athens, Ohio, in 1819 and graduated in 1826. He then studied law and was admitted to the bar in 1827. In 1830 he was elected a member of the lower house of the Virginia legislature and was later re-elected several times. In 1841 he was elected to the United States House of Representatives, and was re-elected in 1843. In 1850 he was elected to the Virginia Constitutional Convention and took a prominent part in framing the new constitution. In 1851 he was the Whig candidate for governor of Virginia, in the first popular election for governor in Virginia, but was defeated by Joseph Johnson, the Democratic nominee. In May 1852 he was elected judge of the eighth judicial circuit of Virginia, but resigned his office 1 July 1858. He was a prominent member of the «Peace Conference» held at Washington in the spring of 1861 and took an active part in defense of the Union. He was also elected a delegate to the Richmond convention which passed the Ordinance of Secession. In the convention he made an able speech in defense of the Union. At the opening of the Civil War he retired to private life upon his farm and thereafter refused to accept office but continued the practice of his profession. He wielded a large influence in western Virginia.

SUMMERS, sŭm'ĕrz, **Thomas Osmund,** American Methodist Episcopal (South) clergyman: b. near Corfe Castle, Dorsetshire, England, 11 Oct. 1812; d. Nashville, Tenn., 6 May 1882. In 1830 he came to the United States where he studied for the ministry and was «admitted on trial» to the Baltimore Conference, 1835. He was active in the organization of the Texas Conference, 1840, and later was sent to the Alabama Conference. He was professor of systematic theology at Vanderbilt University, dean of the faculty and pastor ex officio of that university. He has published 'Commentaries on the Gospels, the Acts, and the Ritual of the Methodist Episcopal Church (South)'; 'Seasons, Months and Days'; 'Talks, Pleasant and Profitable.' Consult 'Life' by Fitzgerald (1884).

SUMMERSIDE, Canada, town and port of entry of Prince Edward's Island, capital of Prince County, on Bedeque Bay and on the Prince Edward's Island Railroad. It is 40 miles northwest of Charlottetown and has an excellent harbor with anchorage for the largest vessels. There are flour and saw mills, manufactures of plows, etc., and is the centre of the recently developed fox ranch industry. Summerside has regular communication in summer by steamer with Nova Scotia and New Brunswick. Pop. 2,678.

SUMMERSVILLE, Ga., city in Richmond County and suburb of Augusta. It lies in a fertile valley 25 miles north-northwest of Rome, on the Central of Georgia Railroad. On account of its mild winter climate it is a popular winter resort. It contains a government arsenal and ordnance department. Pop. 4,361.

SUMMIT, N. J., city in Union County, on the Delaware, Lackawanna and Western Railroad, 20 miles west of New York and 12 miles west of Newark. It is in an elevated part of the county, about 450 feet above tide water. Summit was settled in 1795, and the first school was built the same year. The first church building was erected in 1840. It was incorporated as a township in 1869 and as a city in 1899. It is a purely residential community, noted for its beautiful scenery and delightful climate. The chief industries which contribute to the prosperity of the city are manufacturing silk goods, cultivation of roses, farming and the cultivation of fruit. Summit is a residential city, and has many New York and Newark business men among its inhabitants. The municipal improvements include gas and electric lights, pure water, an excellent tide water sewerage system, well-organized police and fire departments, free postal delivery and telegraph and telephone service. There are eight churches, Y. M. C. A. building and the Arthur Home for Blind Babies under the International Sunshine Society. The educational institutions are Kent Place School, for girls; Summit Academy, for boys; five public schools, one parish school and a free public library. The two banks have a combined capital of $200,000. The government is vested in a mayor and a council of seven members, who hold office for three years. Pop. 9,136.

SUMMONS, *in law,* an admonition to appear in court, addressed to the defendant in a personal action. It is the writ by which a personal action is always commenced. According to English law it need not state the form or cause of action, but it must contain the names of all the defendants, and must have endorsed upon it the name and address of the person taking it out, whether the plaintiff himself or his attorney. It is the duty of the person taking out a summons to serve it on the defendant in person; but if the judge is satisfied that reasonable efforts have been made to do this, and that the defendant knows that the summons has been issued against him, he may authorize the plaintiff to go on with the action without personal service.

SUMNER, Charles, American statesman: b. Boston, 6 Jan. 1811; d. Washington, D. C., 11 March 1874. His family was English in origin, Charles being a descendant in the seventh generation from William, who came to America about 1635 and settled at Dorchester, Mass. The Sumners lived in the same vicinity for the next 200 years and more, generally as farmers. The father, Charles Pinckney Sumner (b. 1776; d. 1839), graduated from Harvard in 1796. He was a lawyer, was married to Relief Jacob of Hanover, N. H., in 1810 and had nine children, of whom Charles was the eldest. The father took an active interest in politics, was clerk of the Massachusetts House of Representatives in 1806–07 and 1810–11 and from 1825 to 1839 was sheriff of Suffolk County. He was interested in the temperance movement and was strongly anti-slavery in feeling. He was fond of books, conscientious, earnest, grave and stern. It was not strange, then, that he brought up his son in the old Puritan style and the latter's career shows that he was greatly influenced by his father's training, views and character.

Charles was educated at the famous Boston Latin School, having as schoolmates Robert C. Winthrop and Wendell Phillips. His tastes were those of the scholar and he read widely and became proficient in the classics. He entered Harvard College in 1826, where he continued to excel in the classics, but also devoted much time to history and literature and perfected himself in oratory or «declaiming.» After a year spent in private study and diligent attendance on the lectures and orations of the great Boston orators, Webster, Everett, Choate and Channing, he entered the Harvard Law School in 1831 and received the personal attention and teaching of Judge Story, an old friend of Sumner's father. His plan of study was thus described in a letter to a friend: «Six hours, namely, the forenoon, wholly and solely to law; afternoon, classics; evening, history, subjects collateral and assistant to law, etc. Recreation must not be found in idleness or loose reading.» In January 1834 he entered the law office of Benjamin Rand in Boston. In February he made a journey to Washington, where he received his first impressions of slavery in the South. His first subscription for a newspaper was for Garrison's *Liberator*. While in Washington he heard Webster, Clay and Calhoun speak in the Senate, but he still thought he preferred law to politics. During the next three years, 1834–36, he practised law in Boston, but without remarkable success. His arguments were in the nature of learned essays rather than forcible presentations of the case in a manner to convince juries.

In 1837 he went abroad and spent three years traveling in France, England, Italy and Germany. In Paris, where he lived five months, he attended university lectures, visited the museums, galleries and historic places, attended the Chamber of Deputies and law courts, went into society and met many eminent persons. He next spent 10 months in England and met the famous men of the day, Carlyle, Wordsworth, Macaulay, etc. In Italy he studied Italian literature. Then he spent several months in Germany and finally returned to America in May 1840. His foreign travel unfitted him for his chosen profession, to some extent, and still further intensified his longings for the scholar's career.

During his absence abroad the slavery question had become a burning issue, though up to this time he had but slight interest in politics or in the great public questions of the period. From 1841, however, his letters commence to show evidence of more positive views on the slavery question and more determination to oppose the further spread and influence of this institution. His humanitarianism showed itself in his interest in popular education and in the support of Horace Mann, in the work for the blind, in that for the improvement of prison discipline and in his opposition to war under all circumstances. In 1843 he commenced to write against slavery, and contended, in opposition to many, that it was a *national* rather than merely a *local* evil: that the nation was responsible and that it might to a large extent remove the evil by abolishing slavery in the District of Columbia and in the Territories, by compelling the rendition of fugitive slaves, by preventing the slave trade, by remedying the laws of slave States which abridged the right of free negroes in free States, by stipulating the conditions of admitting new States and by amending the Constitution so as to abolish slavery. Sumner made his real début in public life by a Fourth of July oration in Boston, 1845, on the «True Grandeur of Nations,» in which he bitterly denounced wars of all kinds as dishonorable. Four months later he made his first anti-slavery speech at a meeting in Faneuil Hall to protest against the annexation of Texas.

In 1846–47 Sumner made several speeches in favor of the Whig party adopting an anti-slavery attitude. He wrote for the newspapers against the Mexican War; declared that it was unconstitutional, unjust and detestable, opposed further expenditures for it, called for the withdrawal of troops and opposed the opening of the territory to be acquired from Mexico to slavery. He joined the Free Soil party of 1848 and was nominated for Congress in October, but failed of election. When Webster, in his speech of 7 March 1850, refused to vote to exclude slavery from California and New Mexico, he became, in the eyes of many in Massachusetts, an apologist of slavery and this situation opened the door of the Senate to Sumner.

In Massachusetts the autumn campaign hinged on the question whether the State should approve the Compromise of 1850 and the course of Webster in supporting it. There was bitter opposition to the Fugitive Slave Law and the manner of its enforcement. Sumner made an important speech in Faneuil Hall 6 November against the Fugitive Slave law and demanded its repeal. This speech made possible his election as senator in January 1851, for in the State election the combined Democrats and

Free Soilers had a majority of the legislature and chose Sumner rather than Winthrop, the Whig candidate, as senator.

With the entrance of Sumner into the Senate in December 1851 a new force for anti-slavery agitation was present. He was an uncompromising, fiery, earnest and persistent antagonist of slavery. He was the spokesman of the anti-slavery forces in the Senate as Calhoun had been for the pro-slavery interests. Although the leaders of both parties were for peace, Clay and Webster on one side and Cass, Buchanan and Douglas on the other, nevertheless Sumner believed that the Compromise of 1850 was wrong and that «nothing can be settled which is not right.» It was not until August 1852, after both the Whig and Democratic National Conventions had declared their support of the Compromise of 1850, that Sumner spoke of the great question, viz., «Freedom National, Slavery Sectional.» His argument was to the effect that slavery was not recognized in the Constitution, that Congress had no power to establish it and that, therefore, it could not legally exist where the jurisdiction of the national government was exclusive; that the Fugitive Slave Law was unconstitutional and, therefore, should not be obeyed. This speech made Sumner the leader of the anti-slavery party and his doctrines were accepted as sound by its rank and file.

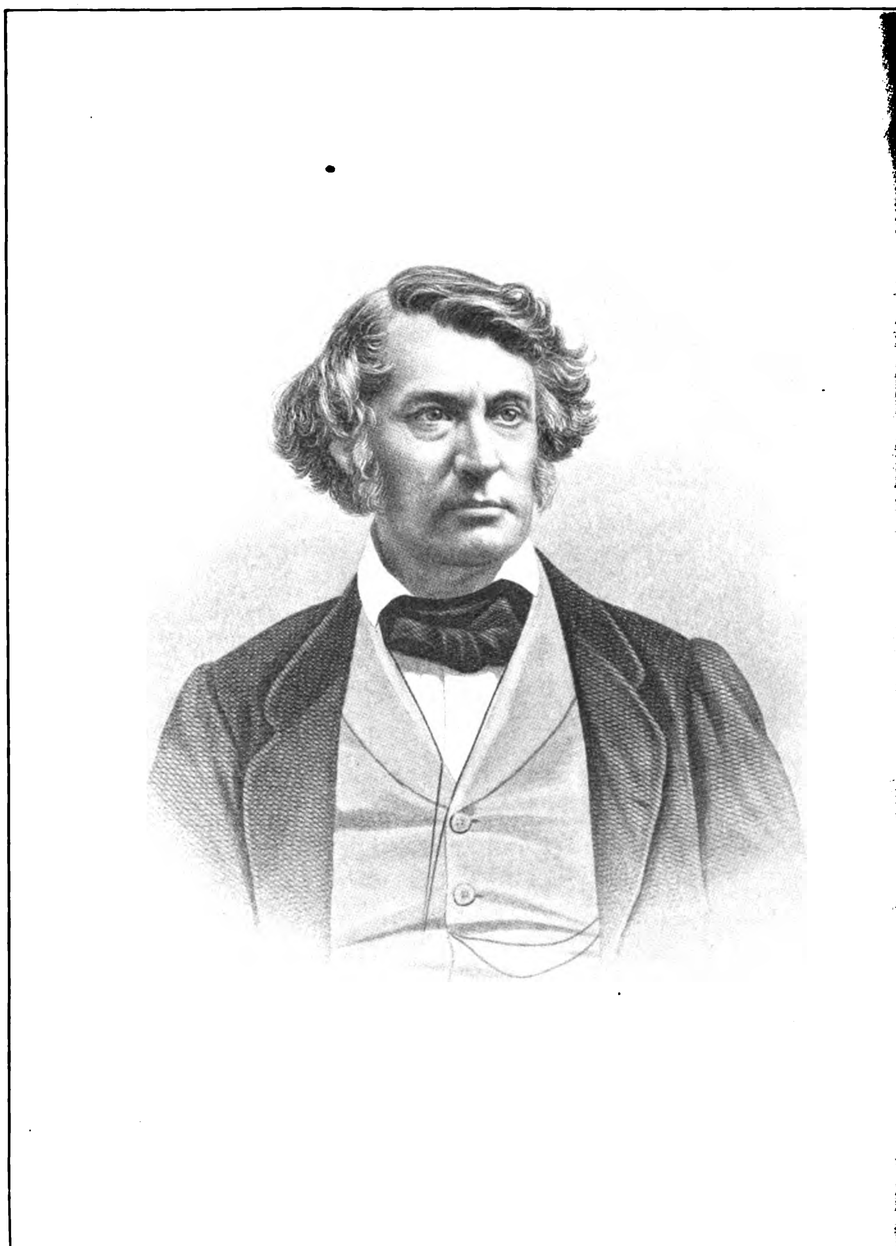
The next Congress, that commencing 5 Dec. 1853, was made famous by the passage of the Kansas-Nebraska Bill, which was designed to repeal the Missouri Compromise. It was on 23 Jan. 1854 that Senator Douglas introduced a bill dividing the Nebraska Territory into Kansas and Nebraska. This bill declared that the Missouri Compromise «was superseded on the principle of the legislation of 1850, commonly called the compromise measure, and is hereby declared in operation.» Sumner spoke against the bill 15 Feb. 1854 and declared that the Missouri Compromise was a binding contract. His speech on 26 June in reply to an attack on Boston and Massachusetts by Southern senators, particularly Senators Butler of South Carolina and Mason of Virginia, aroused great feeling.

The passage of the Kansas-Nebraska Act led to the formation of the Republican party. A Republican convention, composed mostly of Free Soldiers, was held at Worcester, Mass., 7 Sept. 1854 and Sumner spoke for the new party. He advocated resistance to the enforcement of the Fugitive Slave Law and advised the passage of personal liberty laws to nullify its workings. He justified his position by denying that the provision of the Constitution touching the rendition of «persons held to service or labor,» conferred any power on the national government «to establish uniform rules for the rendition of fugitives»; that therefore, each State had the right to determine for itself the extent of the obligation assumed. In consequence the Fugitive Slave Law was unconstitutional and the States had a right to act so as to secure for their citizens claimed as fugitive slaves the right of trial by jury and the privilege of habeas corpus. This view would give the States liberty to construe the Constitution and pass laws which their construction of the Constitution permitted. In case there was a conflict between the Supreme Court and the States in the construction of the Constitution, then no man «will voluntarily aid in enforcing a judgment which in conscience he believed wrong.» This was preaching revolutionary doctrine and was the most violent and extreme position which Sumner had taken up to this date.

In the second session of the 33d Congress, that commencing December 1854, Sumner endeavored to secure a repeal of the Fugitive Slave Law, but was defeated. In the spring of 1855 he prepared an address entitled «The Anti-Slavery Enterprise, its Necessity, Practicability, and Dignity, with Glances at the Special Duties of the North.» This was delivered in Boston, New York and other places. It was in this address that he prophesied the downfall of slavery because of a «moral blockade» against it. «With the sympathies of all Christendom as allies, already it (Anti-Slave movement), encompasses the slave masters by a moral blockade, invisible to the eye, but more potent than navies, from which there can be no escape except in final capitulation.»

Two of the great events of the session of Congress that met 3 Dec. 1855, were Sumner's speech of 19 and 20 May 1856, on «The Crime against Kansas,» and the assault on him by Representative Brooks of South Carolina. It was on 12 March 1856 that Senator Douglas reported a bill for organizing a State government in Kansas. This provided that the steps taken should be prescribed by the territorial legislature. This was the pro-slavery legislature which had been elected in March 1855 as a result of fraudulent votes of Missourians who had entered Kansas for this purpose. Congress had to decide whether it would recognize this legislature or admit Kansas as a free State under the Topeka constitution, which had been formed by the free-state men in the convention which met at Topeka 23 Oct. 1855. The debate on the subject began 20 March and continued for some months. Conditions in Kansas had been going from bad to worse and pro-slavery troops had been disarming free-state settlers, and finally, on 21 May, they made an attack on Lawrence, demanded the surrender of all arms, broke the presses of the newspapers, burned the Free State Hotel and plundered houses and dwellings.

It was under such circumstances that Sumner delivered his famous and carefully prepared speech which he meant to be «the most thorough philippic ever uttered in a legislative body.» In this speech he reviewed the whole case from the passage of the Kansas-Nebraska Bill up to the time of the attack on Lawrence. He criticized the administration and attacked his opponents in the most bitter language, especially Senators Butler of South Carolina and Douglas of Illinois. The former had «chosen a mistress to whom he has made his vows, and who, though ugly to others, is always lovely to him; though polluted in the sight of the world, is chaste in his sight; I mean the harlot Slavery.» Douglas had used language in denouncing Sumner that brought forth the reply that «no person with the upright form of a man» could be allowed «to switch out from his tongue the perpetual stench of offensive personality. Sir, that is not a proper weapon of debate, at least on this floor. The noisome, squat, and nameless animal to which



CHARLES SUMNER

I refer is not the proper model for an American senator. Will the senator from Illinois take notice?" These bitter personalities led to the assault on Sumner on 22 May by Preston S. Brooks, a representative from South Carolina, and a cousin of Senator Butler. The Senate had adjourned and Sumner was seated at his desk writing letters, when Brooks entered and said, "Mr. Sumner, I have read your speech carefully and with as much impartiality as was possible, and I feel it my duty to tell you that you have libeled my State and slandered a relative who is aged and absent, and I am come to punish you for it." He then struck Sumner a series of blows on the head with a gutta percha cane, until he fell bloody and senseless to the floor. An effort to expel Brooks from the House failed because of lack of two-thirds majority. While a resolution of censure was pending Brooks resigned, but was immediately re-elected by his constituents. His action was generally upheld by the Southern leaders and press. The indignation in the North was intense, and the incident crystallized sentiment against slavery more, perhaps, than any other single event had done up to this time.

Sumner was re-elected to the Senate in January 1857, but owing to the state of his health he spent nearly four years abroad, returning in time to resume his seat in the Senate 5 Dec. 1859. It was not until June 1860, however, that he delivered an important speech on "The Barbarism of Slavery." It was intended as a reply to numerous assertions recently made to the effect that slavery was a moral, social and political blessing, and "ennobling to both races, the white and black." The speech was a reservoir of facts drawn largely from Southern sources, and an appeal to the great moral sentiment of the North to help abolish the system.

In the session of Congress which opened 3 Dec. 1860, Sumner devoted himself to preventing any compromise between the slave and the free States; for his object was the destruction of slavery. When the Southern senators withdrew as a result of secession, the committee was reorganized, and Sumner was made chairman of the committee on Foreign Relations. In this capacity he rendered the country signal service during the war. He was largely instrumental in the surrender of the captured Confederate commissioners, Slidell and Mason, who had been taken from the English mail steamer *Trent* by Captain Wilkes while on the high seas. He showed the President that this would be in accordance with our doctrines and an abandonment of claims made by England to which we had always objected. He used all his influence to prevent foreign intervention, and opposed the use of force in an attempt to get the French troops out of Mexico, as it might result in war. He was opposed to the issuing of letters of marque, and when the bill was passed used every effort to prevent the law going into effect, in which he was successful. His argument was that it would embroil us with foreign nations. His speech in New York, 10 Sept. 1863, was a strong statement of the American position. He raked England for her unfriendly acts with respect to neutrality and for allowing Confederate cruisers to be fitted out in English ports, and called France to account for her intervention in Mexico. The speech had an important effect in putting a check on England. He made an exhaustive report on the French Spoliation Claims. He argued vigorously for the treaty for the purchase of Alaska in 1867. He was in favor of settling all questions of dispute with England and in bringing the two nations into relations of harmony and good will, and hence supported the efforts to settle the *Alabama* claims. Owing to a disagreement with President Grant and Republican senators over the acquisition of Santo Domingo, which Sumner opposed, he was removed from his chairmanship of the Committee on Foreign Relations, 10 March 1871.

Sumner supported the policy of emancipation and wished to take the step before Lincoln finally acted because he thought that it would prevent foreign intervention. He made the first public demand for emancipation by a responsible statesman on 1 Oct. 1861, before the State Republican Committee of Massachusetts, and repeated his demand in a number of cities in the next few months. In the session of Congress which met in December 1861, he spoke in favor of legislation to prevent the surrender of fugitive slaves by the Union army, and in favor of the abolition of slavery in the District of Columbia, the first public word on the subject since the Republican party came into power.

During the war and after he was active in furthering the interests of the negro. He was influential in getting ratified the treaty with England for the more effectual suppression of the slave trade. He proposed bills allowing colored persons to become mail carriers, for enlisting negroes freed by Confiscation Act and for receiving colored volunteers. He proposed and carried legislation preventing the exclusion of witnesses in the courts of the District of Columbia on account of color. He voted against the bill to admit West Virginia, because the Senate refused to amend it so that after 4 July 1863 slavery should cease in that State. He was continually urging Lincoln to issue the Emancipation Proclamation. He introduced a bill in the Senate to repeal all fugitive slave laws, and succeeded in getting a similar bill, which had been passed in the House, through the Senate. He began the contest for negro suffrage, was a leader in his effort to prevent the exclusion of colored persons from street cars in the District of Columbia, supported a bill to secure for colored soldiers equal pay with the white and was energetic in getting the bill passed to establish the Freedman's Bureau, which Sumner called "a bridge from slavery to freedom." He also aided in forcing a repeal of the law which excluded colored testimony in the United States courts, and was largely responsible for the admission of a colored man to the bar of the Supreme Court, the privilege being granted by Chief Justice Chase on motion of Sumner. He offered an amendment to one of the reconstruction measures to the effect that "every constitution in the rebel States shall require the legislature to establish and maintain a system of public schools open to all without distinction of race or color."

On the question of reconstruction, Sumner felt that the conditions must be faced by Congress and the President together, and hence opposed the policies of Lincoln and Johnson, viz., reconstruction by the executive. He considered this policy unconstitutional while the Constitution supported the authority of Congress — its duty «to guarantee to every State in this Union a republican form of government.» He voted for the conviction of President Johnson in his impeachment trial.

After his removal as chairman of the Committee on Foreign Affairs, Sumner exerted little influence in the Senate, and occupied his time mainly in pressing civil rights bills for negroes. He supported Horace Greeley for President in the election of 1872, on the ground that he was an «unswerving» Republican, that principles must be preferred to party and that Grant was unfaithful to the Constitution and Republican principles.

The character of Sumner and his services to his country were both based on fidelity to great moral principles. He was sincere, unselfish, simple, kind, conscientious, honest and pure and without envy or personal animosity. He was also energetic, uncompromising, courageous and fearless, and indomitable in his purpose. On the other hand, while not entirely a man of one idea, his intense convictions on slavery often helped to defeat his desires, because of his inability to give sufficient weight to other important interests. He became egotistical, dogmatic, irritable, and was lacking in a sense of humor. Next to Lincoln he undoubtedly did more to win freedom for the colored race than any other man. His other great service was in keeping the country out of war with England and France during the period of the Civil War, when such a catastrophe might easily have led to a permanent dissolution of the Union.

Bibliography.— The best short life of Sumner is that by Moorfield Storey ('American Statesmen Series,' Boston 1900). Other biographies are those by Edward Lillie Pierce, 'Memoir and Letters of Charles Sumner' (4 vols., Boston 1877–93); by Anna L. Dawes, 'Charles Sumner' ('Makers of America Series,' New York 1892); by George H. Haynes ('American Crisis Biographies,' Philadelphia, Copyright, 1909); by G. H. Grimke, 'Life of Charles Sumner, the Scholar in Politics' (New York 1892). The «Works» of Sumner were published in 15 volumes, Boston 1874–83. A famous oration on Sumner is that by L. Q. C. Lamar, 27 April 1874. Consult also Shotwell, W. G., 'Life of Charles Sumner' (New York 1910), and Whipple, E. P., 'Recollections of Eminent Man.' Some of Sumner's most famous speeches have been printed separately, viz., «Report on the War with Mexico,» and «Speech on the Crime against Kansas» (Directors of Old South Work, Boston); «Address on War, containing True Grandeur of Nations»; «War System of Nations»; «Duel between France and Germany» (Boston).

MARCUS W. JERNEGAN,
Associate Professor of History, University of Chicago.

SUMNER, George Watson, American naval officer: b. Michigan, 31 Dec. 1841. He was appointed to the navy in 1858. In the Civil War he participated in the bombardment of Forts Jackson and Saint Philip; commanded the *Massasoit* on the James River, and with the *Onondaga* forced the Confederate ironclads to relinquish the purpose of attacking Grant's transports and base of supplies at City Point, Va. After the war he served in various capacities, was commandant of the naval station, Port Royal, S. C., 1899–1901; and in January 1901 was appointed commandant of the Philadelphia navy yard.

SUMNER, Increase, American statesman: b. Massachusetts, 1746; d. 1799. He was graduated at Harvard College in 1767; admitted to the bar in 1770, and in 1779 was a member of the State Constitutional Convention. He was elected to Congress in 1782, was a member of the United States Constitutional Convention in 1789, and in 1797 was elected governor of Massachusetts.

SUMNER, Samuel Storrow, American military officer: b. Pennsylvania, 6 Feb. 1842. He was appointed to the army from New York in 1861, served in the Civil War, and against the Indians in the campaigns from 1869 to 1878. In May 1898 he was appointed a brigadier-general of volunteers and in the Spanish-American War was assigned to duty in Cuba. He was ordered to England as military attaché, but left there in 1900 to join the United States troops in China. Later he was sent to the Philippines, where he was promoted brigadier-general United States army in 1901, and major-general, August 1903. His last service was in command of the Division of the Pacific, and he retired 6 Feb. 1906.

SUMNER, William Graham, American educator: b. Paterson, N. J., 30 Oct. 1840; d. 12 April 1910. He was graduated at Yale in 1863, studied abroad, was tutor at Yale in 1866–69, in 1867 took orders in the Protestant Episcopal Church, was assistant at Calvary Church, New York, and rector of church of the Redeemer, Morristown, N. J., appointed professor of political economy and social science at Yale College in 1872. His writings include a translation of Lange's 'Commentary on Second Kings' (1872); 'History of American Currency' (1874); 'Life of Andrew Jackson' (in 'American Statesmen' Series, 1882); 'What Social Classes Owe to Each Other' (1883); 'Problems in Political Economy' (1884); 'Protectionism' (1885); 'History of Banking in the United States' (1896); 'Robert Morris' (1892).

SUMPTUARY LAWS, a term often used in American political discussion with reference to laws regulating the sale of liquor. The original meaning, however, was the regulation by law of eating and drinking, wearing apparel and style of living generally. The early settlers of New England adopted harsh laws of this character, which have been exaggerated and caricatured in the fictitious Connecticut «Blue Laws» of the Rev. Samuel A. Peters.

Sumptuary laws existed in ancient as well as modern times. One of the Roman laws or the Twelve Tables aimed at repressing extravagance in funerals. After the establishment of the censorship those holding this office had the right of punishing those guilty of luxurious living. After the Twelve Tables the first sumptuary law passed at Rome was the *Lex Oppia* (215 B.C.), directed exclusively against the extravagance of women in dress, jewelry, etc. This law was repealed 20 years later. The other sumptuary laws enacted at Rome were almost exclusively designed to keep down extravagance in entertainments. The *Lex Julia,* passed in the reign of Augustus, was the last sumptuary law passed at Rome, but a few endeavors were made under later emperors also to repress luxury by decrees of the Senate and imperial edicts. The last attempt of this nature that is known to have been made belongs to the reign of Nero. Sumptuary laws were revived by Charlemagne. Both he and Louis the Débonnaire promulgated capitularies against luxury in dress and furniture. Various other laws and decrees having a like object were made under many of the later kings of France, even down to Louis XV. A royal ordinance, dated 19 April 1737, forbids the common people (*vilains*) the use of calico, which was reserved for the nobility, and there are instances of the wives of commoners being fined in virtue of this decree. In England sumptuary laws began to be enacted in the reign of Edward III, and continued to be passed down to the time of the Reformation. Most of them were repealed by 1 James I, ch. xxv, but they were not all expunged from the statute-book till 1856.

Sumptuary laws in the early colonial period of America were not confined to New England. Directions were sent to Virginia in 1621 not to permit any but members of the council to wear gold in their clothes, «or to wear silk till they make it themselves.» In New England the Massachusetts magistrates prohibited the wearing of gold, silver or thread lace, all embroideries or needle-work in the form of caps, bands or rails, gold and silver girdles, and other extravagances which offended Puritan simplicity. The laws were, however, ignored or but slightly enforced, and gradually became obsolete. At present in the United States dress is solely a question of decency, and sumptuary laws are, in that sense, of the past.

SUMTER, Thomas, American military officer: b. Virginia, 1734; d. 1 June 1832. After the capture of Charleston by the British in 1780 he took the field as a brigadier-general at the head of a body of light horse and soon became one of the most active and able partisan leaders of the South. His bravery, endurance and unvarying cheerfulness and determination under reverses gained him from his followers the sobriquet of the «Carolina game cock,» and Cornwallis confessed that he was one of his «greatest plagues.» After gaining important successes over the British and Tories, he was, in September 1780, routed with considerable loss near the mouth of Fishing Creek on the Catawba by Tarleton. In 1781 he took a distinguished part in the battle of Eutaw Springs. The thanks of Congress were tendered him in 1791, and he was afterward sent to that body as a representative of South Carolina. In 1809 he was appointed United States Minister to Brazil and two years later was elected United States senator.

SUMTER, S. C., city, county-seat of Sumter County, on the main line and several branches of the Atlantic Coast Line Railroad, 80 miles north of Charleston. It is in an agricultural region, producing cotton, tobacco and vegetables, of which it exports large quantities. It also has manufacturing interests of importance which include cotton factories, planing mills, sash and blind factories, etc. There is a national bank and a State bank. The city has a public high school founded in 1889, and is the seat of Saint Joseph's Academy, a Roman Catholic school for girls, and of the Sumter Military Academy and Female Seminary, a coeducational non-sectarian school. Since 1913 the commission form of government administers city affairs. Pop. about 9,400.

SUMTER, Fort. See FORT SUMTER.

SUMY, soo'mē, Russia, a town in the government of Kharkov, on the river Psiol, 83 miles north of the town of Kharkov. It has nine churches, a gymnasium, technical school, banks and a large sugar refinery, besides numerous distilleries. The soil is productive, and agricultural products are exported together with brandy. Four annual fairs give considerable impulse to trade. Pop. 51,500.

SUN, the great central body of the solar system. The aspect of the sun with which all are familiar from infancy shows that it is a shining globe. Astronomical measurements show that this globe is more than 100 times the diameter of the earth, and, therefore, more than 1,000,000 times its volume. Its small apparent diameter is due to its enormous distance of 93,000,000 miles. The following are more exact numerical particulars:

Mean distance (miles)	92,900,000
Eq hor. parallax	8.80″
Density (water = 1)	1.41
Mass (earth = 1)	332,800
Diameter (miles)	866,400
Gravity (earth's = 1)	27.65

For methods of determining the distance and other quantities see ASTRONOMY, *Theoretical.* The aim of the present article is to set forth the physical constitution of the sun, so far as modern research has made it known.

One of the most certain results of research is that the sun is at an extremely high temperature, higher than any that we can produce in our furnaces. This is shown by two considerations. One is the enormous amount of energy radiated, which suffices to keep the earth warm and support life on its surface, notwithstanding the immense distance at which it is placed. Nothing but a hot body could radiate so great a volume of energy. Another proof of the high temperature is shown by the spectroscope, which discloses the vapor of iron and other refractory metals in the sun's atmosphere. It requires a hot furnace to melt iron. Much higher must be the temperature which would make it boil away like water. The temperature of the sun not only does this, but the fact that the spectral lines of iron are dark on a bright ground shows that the solar light emanates from a body yet hotter than the vapor of iron.

Aspect of the Sun.— We can see only the surface of the sun, not its vast interior. To distinguish the two, the shining surface is called the «photosphere.» The latter presents to our view the appearance of a flat disc. The edge of this disc is called the «limb.» When seen without telescopic magnification, through a dark glass or other medium, the disc of the sun appears quite uniform, slightly shading off in tint at the limb. But when carefully examined with the telescope, under good atmospheric conditions, the entire photosphere appears as a darkish background, sprinkled with brighter grains or nodules. These «rice-grains» are quite irregular in size and form, and appear as if bright on a relatively dark or yellowish background. It is probable that they are produced by currents of heated matter from the interior, hereafter to be described, which are constantly rising to the surface, there to radiate their heat and then fall back again. When the intensity of the heat radiated from different parts of the photosphere is accurately measured, it is found that the amount of radiation diminishes from the centre of the disc to the limb, where it is least. The diminution is slow at first, but increases quite rapidly at the limb, where it is little more than one-half of that at the centre. The light diminishes in a still greater ratio than the heat. The tint of the light is also different at the centre and at the limb, although this would hardly be noticed by the eye. The light at the limb has more red in its composition than at the centre. This effect is especially noticeable at the time of a total or annular eclipse of the sun. When the moon has nearly covered the sun, the remaining light has a lurid aspect, as if the sun were shining through a smoky atmosphere, thus giving to observers the illusion that the sky is hazy. There can be no doubt of the cause of this appearance. The sun, like the earth, is surrounded by an atmosphere; but this atmosphere is cooler than the photosphere which sends out the light and heat. The existence of the atmosphere is demonstrated by the lines of the spectrum, as well as by the absorption of heat at the limb, which is greater than near the centre because the light coming from that portion of the photosphere has to pass through a greater depth of the atmosphere than when it rises directly upward from the centre.

The Solar Spots.— When the Galilean telescope was first pointed at the sun, the observers were surprised to find that that object was now and then variegated by dark spots. These were observed by Galileo, Scheiner and Fabritius. The two latter published more or less elaborate treatises on the subject, but with their imperfect instruments they were not able to learn much as to the laws of these objects. We now know, with the modern perfected methods of observation, that the spots are of very different sizes, ranging from the minutest point visible in the telescope to a size so great as to be perceptible to the naked eye. The largest must, therefore, exceed the earth itself in diameter. These objects are usually very irregular in their outline, being frequently jagged and cornered, as if made by a shot or bunch of shot passing through a tin plate or wooden plank. They frequently appear in groups; indeed a spot visible to the naked eye commonly consists of a group of these objects close together. The spots of the group may run into each other to any extent, forming an irregular and jagged mass. Sometimes a spot has almost the appearance of a crack in the photosphere. In the spot two portions can generally be distinguished, a dark interior called the «umbra» and a shaded border much brighter than the umbra, though not quite so bright as the photosphere, called the «penumbra.» When the atmosphere is steady, the latter is seen, with a good telescope, to be not of uniform shade, but to be striated, presenting an appearance somewhat like that of a thatched roof. This can be seen better by a figure than by a long description. A spot seems black only by contrast with the brilliancy of the sun. If it were possible to cut off the sun's light, the light from the spot itself would be of dazzling brightness.

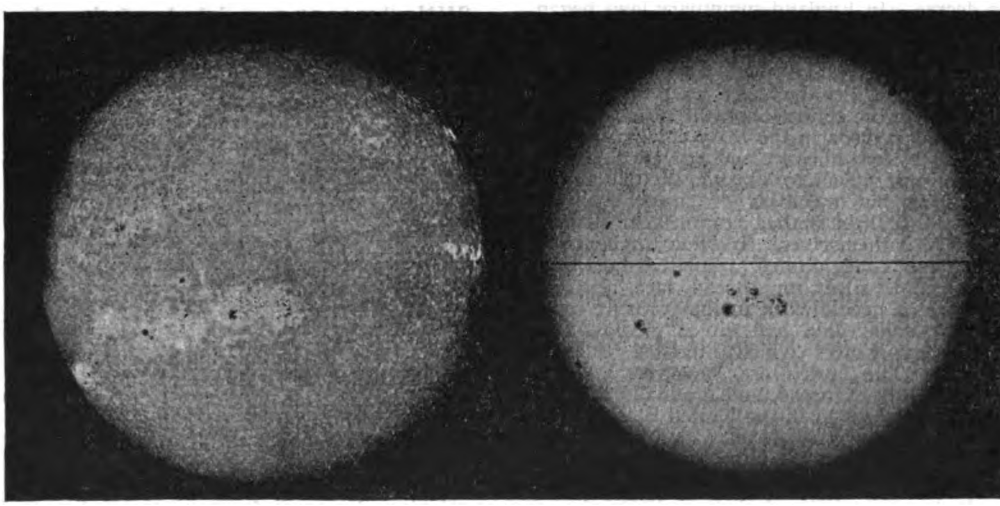


Fig. 6.—On the left is a monochromatic (Spectroheliogram) of the sun taken with the light at the centre of the dark Fraunhofer line known as H, due to calcium vapor. The instrument used was the Rumford spectroheliograph of the Yerkes Observatory. Numerous areas of calcium vapor, lying at a high level in the sun's atmosphere, are thus brought to light. They are not seen on the direct photograph to the right, which shows the sun as photographed in the ordinary way. A considerable number of spots will be noted. The horizontal black line across the photograph gives the east and west direction.

It was formerly supposed that the spots were openings in the photosphere, through which a darker interior was seen. This conclusion was reached because it was supposed that when the spot approached the edge of the solar disc the penumbra looked broader on the side of the spot next the edge. But careful observations made in recent times show that this is not the case. Sometimes the penumbra is broader at one edge and sometimes at another. It was also supposed that the spots might be something in the nature of cooler dark metals floating on the photosphere. But this view also has been abandoned. It has recently been shown by Hale that a sun spot is an immense vortex, in which whirling electrically charged particles produce an intense magnetic field. Thus a sun spot resembles a terrestrial tornado. The observations of Evershed and St. John indicate that the gases are rising from the interior of the sun toward the surface, flowing nearly radially outward above the surface from the centre of the spot. Measurements of the heat radiated from the spot, as compared with that of the neighboring disc, show that the spot is really cooler than the rest of the photosphere. Spectroscopic observations agree with this by showing a great absorption of the light coming from the interior of a spot.

Another salient feature of the sun is its rotation on an axis deviating only six degrees from a line perpendicular to the ecliptic. The time of rotation is shown by observations of the spots on the sun, which we see to move from east toward west. The relation of the sun to its axis of rotation is much the same as in the case of the earth. The sun's axis intersects the photosphere at two opposite points called the *poles* of the sun. A circle passing round the sun midway between the poles is called the *solar equator*. Distances north and south of the equator are called solar latitude. When we look at the sun at noon its north and south poles are near the upper and lower points of the disc; and the equator passes horizontally, or nearly so, across the centre of the disc. The position of the sun's equator is more exactly defined by the following numbers:

Inclination to the ecliptic..................	7°	15′
Longitude of the node......................	74°	29′

The earth in its annual course around the sun passes through the line of the nodes about 5 June and 5 December of each year. At these times the apparent paths of the spots across the sun's disc are straight lines. At the intermediate times they are more or less curved. In March the south pole is slightly turned toward us, and the paths of the spots are curved upward. In September the reverse is the case. We see only the north pole, and the paths are curved downward.

Observations of the spots lead to the unexpected conclusion that the equatorial regions of the sun rotate in less time than those nearer the poles, although the distance they have to go is greater. The sun is so much larger than the earth that, although the time of rotation is more than 25 times as long, yet the absolute linear velocity of the rotation near the equator is four times as great as that of the earth's rotation, being very nearly one mile per second.

The observations of Carrington give the period of rotation as follows:

At the sun's equator..........................	24.9 days.
At 30° of latitude............................	26.4 "

The apparent time of rotation, as we see it, is nearly two days longer, because the earth has carried us forward in its annual motion while the sun is rotating, and the spot has to catch up to our direction before a rotation seems complete.

The rotation of the sun can also be determined by means of the spectroscope, through this instrument enabling us to determine whether a luminous body is approaching the earth, or receding from it. In consequence of the rotation, the photosphere on the east side of the sun is continually moving toward us, and that on the opposite side moving away from us. The observations made by this method agree with those made on the solar spots in giving a period of about 25 or 26 days; but they are discordant as to the variation with latitude. The angular motions in the different latitudes, found by two observers with the spectroscope, Duner and Adams, are as follows:

Daily Angular Rotation of the Sun in Different Latitudes, from Spots and Spectroscopic Observations.

Latitude	Spots (Carrington)	Spectroscope	
		Duner	Adams (1908)
0..........................	14.46°	14.14°	14.65°
11..........................	14.29	13.80	14.43
15..........................	14.13	13.66	14.28
21..........................	13.90	13.40	13.86
30..........................	13.65	13.06	13.64
45..........................	13.10	11.99	12.78
60..........................	....	10.62	11.52
75..........................	....	9.34	10.86

It is a remarkable and interesting fact that the velocities thus determined by the displacement of spectral lines differ systematically when the lines of different elements are chosen. Thus, the values determined by Adams from the lines of iron, calcium and hydrogen, are as follows:

Solar Latitude	Iron lines	Calcium lines	Hydrogen lines
0.3°..................	14.65°	15.0°	15.2°
14.9..................	14.31	14.9	15.0
29.7..................	13.65	14.2	14.6
44.7..................	12.85	13.6	14.0
60.0..................	11.53	12.5	13.7
74.9..................	10.93	13.1	14.3

This difference agrees with much other evidence on the same point in indicating that the different elements effective in producing the lines lie at different levels around the ball of the sun.

The rotation of the sun must produce an ellipticity or bulging out of the equator, as in the case of the earth. But this effect is so small as to elude all astronomical measurement. To all appearance the sun, notwithstanding its rotation, is a perfect sphere.

Two very remarkable laws govern the solar spots, one relating to their frequency, the other to the region of the sun's disc on which they are seen. We recall the fact of the sun having north and south latitude as we have on the earth. The first peculiarity of the spots is that they are rarely seen at more than 35° to 40° of solar latitude, north or south. They are most numerous at about 15° latitude, and from that parallel grow less numerous both toward and from the equator. At the equator they are comparatively scarce. Thus we see that there are two zones of spots; one north and the other south of the sun's equator. The following table of the number of spots observed by Carrington in different zones of latitude illustrates the law:

Limiting lat. of zones	Number of spots
0° to 5°	471
5 to 10	1,940
10 to 15	2,522
15 to 20	2,158
20 to 25	1,303
25 to 30	740
30 to 35	203
35 to 40	84

The other remarkable feature of the spots is their periodicity. At intervals of 11 years they are very numerous, while at the intermediate times they are comparatively scarce, none being visible for perhaps half the time. It is found that the period is almost exactly 11 years 47 days. It was at one time supposed to be the same as the period of revolution of Jupiter, which is somewhat less than 12 years. Had such been the case we should have concluded that the spots were in some way produced by the action of that planet. But it is now proved that the period is more than six months less than that of Jupiter, and does not coincide with any other period known in the solar system. Its average duration is found to be 11.13 years; but it is subject to changes of a year or more. We, therefore, conclude that the cycle of change in the spots is due to a round of processes going on inside the sun itself. What these may be we have no means of determining.

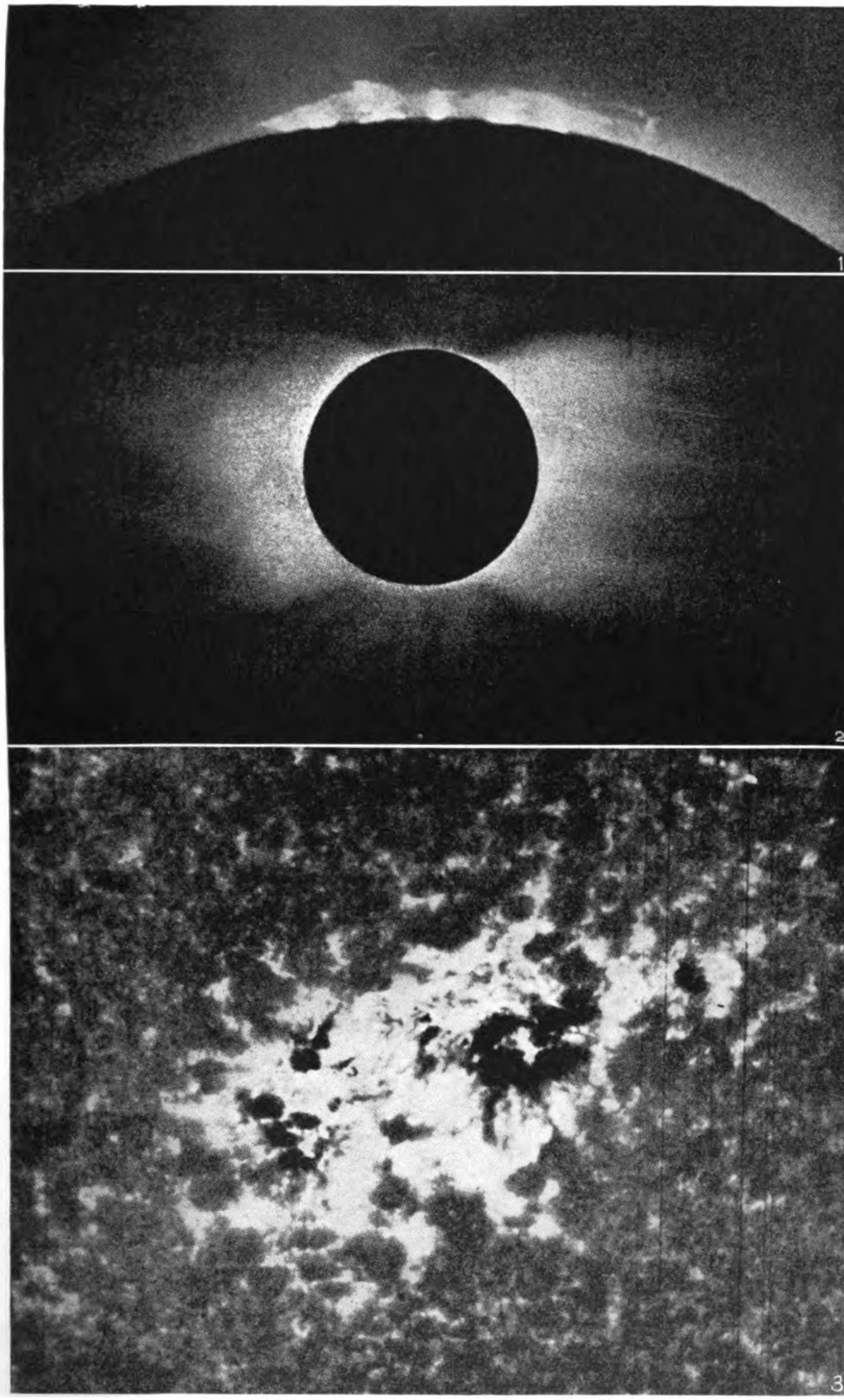
The very careful series of photographs of the sun made at the Greenwich Observatory during the past 30 years show a singular law of variation in the spots with the 11-year period. After a space of two or three years, during which, as we have said, the spots are few and small, the first evidence of a renewal of activity is seen in the occasional appearance of a spot at an unusually high latitude, say 30° to 35° north or south. This may continue for several months, or even a year. Then the spots begin to be more frequent nearer and nearer the equator, while there are fewer beyond 30° of latitude. Finally, after three or four years, they become thickest of all, as we have said, in about 15° of latitude. About five years from the time when fewest are seen, they will be most numerous; then they will also be seen nearer the equator, or even on the equator itself. After five years they begin to diminish rather more slowly than they increased, until they gradually seem once more almost to disappear. The years of minimum sun spots are 1889, 1900, 1911, etc. The years when they are most numerous were 1882, 1893, 1904, etc. But these dates are only approximate, as the intervals between the minima are not always exactly the same.

The Faculæ.— Another curious feature of the sun is the occasional appearance of spots brighter than the rest of the photosphere. These commonly appear in bunches in the neighborhood of the spots, and derive their name from the Latin word *facula,* a torch. They follow a law similar to that of the spots not only in having the same period of frequency, but in being most numerous where the spots are most numerous. But they are seen over a very much wider region of the sun's disc than the spots, sometimes, although rarely, near the poles of the sun.

A third feature of the sun associated with the spots and the faculæ is known as the "prominences." These can be actually seen through an ordinary telescope only during total eclipses of the sun. But they may now be seen at any time, when the air is clear, by means of a powerful spectroscope. Like the faculæ, they are commonly, but not always, found in the neighborhood of the spots, being seen from time to time all round the sun's limb. (See Eclipse). They will be described more fully hereafter.

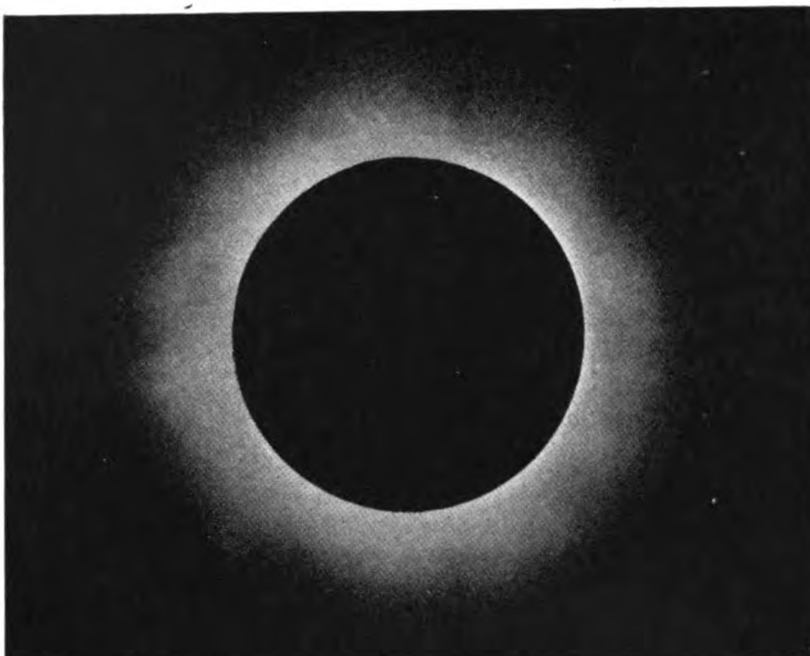
It is quite evident, from what we have said, that the spots, faculæ and prominences are all results of one series of operations. This fact has been brought out in a very interesting way by the spectroheliograph. This is an instrument invented by George E. Hale of the Mount Wilson Observatory, which enables a photograph of the sun to be taken by the light of a single ray of the spectrum, the light from all the other rays being cut off. A ray frequently used for the purpose is one emitted by calcium. When a photograph is taken with this ray, we have not a general photograph of the sun by all its light, which is what the ordinary camera would give us, but a photograph in which no light is allowed to enter except that emitted by the vapor of calcium. A photograph thus taken is found to be extremely variegated, some parts of the sun's disc being much brighter than others. The interesting feature is that, in the general average, the brightest parts of the disc are those where the spots, faculæ, and prominences are most numerous. But these bright patches may appear on any part of the sun. The general conclusion is that the three classes of objects we have described are all produced by processes going on in the sun which result in the throwing up of great masses of calcium vapor.

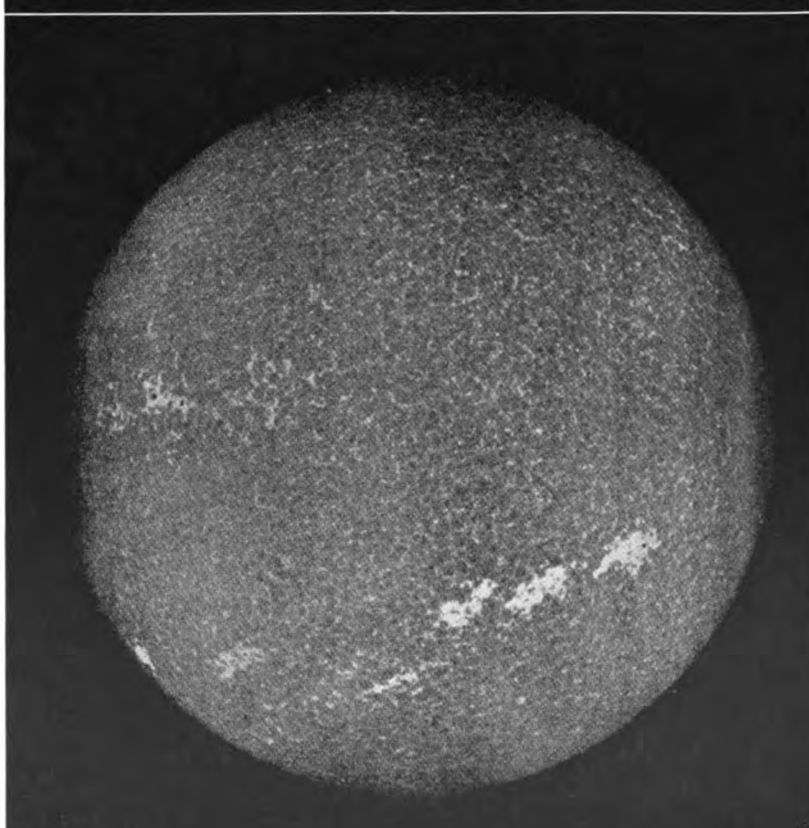
Having thus described what the sun is in a general way, and shown its appearances, we pass on to particulars respecting its constitution and surroundings. Our conclusions must be drawn step by step from the phenomena exhibited by the photosphere, combined with reasoning upon the laws of force and the properties of matter. A conclusion most easily reached is that the sun is not a solid body throughout. If it were, its enormous radiation of heat would result in the surface rapidly cooling off, so that, in a very short time, it would cease to emit light. Moreover, a study of the surface shows changes constantly going on incompatible with the idea of solidity. It follows that the heat radiated from the surface must be continually supplied, either by the rising up of hot material from the interior, or by radiation from within outward. It is the latter which is believed to be acting. For the material of the sun is probably transparent, and it is supposed that the enormous heat is absorbed and re-radiated as we pass outward from the center.



1 Prominences on the edge of the sun. Photographed during the total solar eclipse, in Algiers, 30 August 1905
2 The corona of the sun during the total eclipse of 28 May 1900
3 Calcium flocculi in the neighborhood of a sun-spot. Photographed with the spectro-heliograph, 10 October 1903, at the Yerkes Observatory

SUN





1 The appearance of the corona during the total eclipse of 30 August 1905
2 Spectro-heliogram of the whole ball of the sun taken at the Yerkes Observatory, 12 August 1903

The absorption and re-radiation from successive layers is almost instantaneous, the velocity of heat transference approaching 180,000 miles a second.

In drawing our conclusions the intensity of gravitation on the sun must be borne in mind. It has nearly 28 times the force of gravity on the earth. A man of ordinary size would weigh two tons at the surface of the sun, and would, therefore, be instantly crushed to death by his own weight, were it possible for him otherwise to exist there. Consequently, the pressure to which the vapors of the sun are subject increases with enormous rapidity below the surface.

The average specific gravity of the materials composing the sun can be determined by astronomical theory with great exactness. It is known that the mean specific gravity is about 40 per cent greater than that of water, and one-quarter that of the earth. It is doubtless much smaller than this at the surface, and, therefore, increases toward the centre. A calculation of the resulting pressure shows that near the centre of the sun the pressure produced by the enormous mass and gravitation of the matter composing the solar orb amounts to about 5,000,000 tons per square inch. This pressure is so far beyond any that we can produce at the earth's surface that we are unable to say what effect it would have upon matter.

Yet another unknown factor is the temperature of the interior. At no great distance toward the centre the temperature exceeds our powers of determination — it may even be 1,000,000°. As the highest temperature which it is possible to produce artificially probably does not amount to 12,000°, it is impossible to say what effect such a temperature would have upon matter. Thus we have two opposing causes, the one an inconceivable degree of heat, such that, were matter exposed to it on the surface of the earth, it would explode with a power to which nothing within our experience can be compared, and a pressure thousands of times any we can produce, tending to condense and solidify this intensely heated matter. One thing which we can say with confidence as to the effect of these causes is that no chemical combinations can take place in matter so circumstanced. The distinction between liquid and gaseous matter is lost under such conditions. Whether the central portions are compressed into a solid, or remain liquid, it is impossible to say.

Modern research shows that the sun, as a whole, is a complex body, the various parts of which are in very different conditions. Beginning at the centre and passing outward, we have first the vast, invisible interior which forms the globe itself, and which our sight can never penetrate. Surrounding this interior is the visible photosphere, or seeming surface, which we see with the naked eye or the telescope, the appearance of which has been fully described. So far as ordinary direct observation could show, this would be the whole of the sun. But the spectroscope, as well as eye observation during total eclipses, has shown most complex surroundings of the sun, which would otherwise have been invisible. The surroundings are formed of two envelopes, the chromosphere and the corona.

The earliest accurate observers of total eclipses with the telescope noticed that during the total phase red cloud-like masses were seen here and there projecting beyond the limb of the dark moon. Moreover, at the beginning or the end of the eclipse, it is found that these projections are connected with a red border extending round the sun. There is, therefore, an envelope which radiates red light and surrounds the sun, and which is invisible except during eclipses. Quite independent of this envelope is a bright effulgence which is seen during a total eclipse. These phenomena are fully described in the article ECLIPSE. What we have now to do is to set forth what they indicate.

The red envelope which rests immediately on the photosphere is called "chromosphere." It is comparatively thin — so thin as to be almost immediately covered when the sun is totally eclipsed. Its nature was first made known by the spectroscope, which showed it to be composed mostly of hydrogen, helium, and calcium vapor. Its principal and lower parts differ in constitution. At the photosphere it comprises nearly all the substances which exist in the latter. This was shown in a very beautiful way by observations of the reversing layer, first made by Young at the total eclipse of 1870. The explanation of the phenomena there described is that the photosphere is hot enough to shine by its own light, and, being a gas, to give bright spectral lines. But the photosphere is so much hotter than the chromosphere that the latter is, in comparison, a cool gas which absorbs the spectral lines from the light radiated by the photosphere. The question of the density of the chromosphere and reversing layer, as its base is called, has given rise to very varied estimates.

The fact that the spectroscope shows bright lines as the last ray of true sunlight disappears at the beginning of a total eclipse shows that the gas from which these lines emanate must be so rare as to be transparent through a distance of thousands of miles. We are, therefore, justified in concluding that the gases of the chromosphere are extremely rare, and the same is probably true of the principal regions of the photosphere.

Among the most extraordinary phenomena exhibited by the sun are the mountainous elevations of the chromosphere, which we see as the red protuberances already described. These are of two kinds, the eruptive and the cloud-like. The latter present to us the appearance of vast clouds floating in an atmosphere of the sun. It seems certain, however, that they cannot be what they seem, because there can be no atmosphere there to support them. They are probably held up by an impulsion of the solar rays, which will be described presently. The eruptive prominences seem to be due to outbursts of intensely hot gases, mostly hydrogen, from the sun. These are thrown up with a velocity of several hundred miles per second, like immense mountains of fire. They sometimes rise to a height of many thousand miles, their ascent being doubtless aided by the impulsion of the solar rays; then they fall back again to the sun. The chromosphere and prominences can now be photographed in projection against the sun's disc with the spectroheliograph. When such photographs are made with the light of the red hydrogen line, they show great vortex phenomena, centering in sun spots and closely related to the vortices in the photosphere which constitute the spots themselves. See Plate III.

The violent forces seen in action in the chromosphere are in singular contrast to the soft white light of the corona. Much mystery still surrounds the constitution of the latter. It was supposed to be an atmosphere of the sun; but this view is rendered untenable by the fact that an atmosphere supported by its own weight would more than double in density for every mile that it was nearer its base. It probably consists of exceedingly minute molecules of gaseous matter, similar to those which make up the tail of a comet, and possibly having some resemblance to the latter. The newly-discovered fact of the impulsion of the solar rays probably affords a clew for an explanation of these and similar phenomena. More than 40 years ago it was announced by Maxwell, as a result of his electro-magnetic theory of light, that light and heat emitted by the sun should exercise a very minute pressure on any object which they struck. Conclusion showed that this pressure was so slight that no apparatus then known was so delicate as to make it sensible. Within the last few years, however, E. F. Nichols and others have succeeded in showing experimentally that on very finely divided matter this action of light can be observed and measured. It follows that particles below a certain size will be repelled by the sun's light with greater force than they are attracted toward it, and will thus be driven from the sun when in its neighborhood, or supported temporarily at a certain height above the sun. Hale has proved, by spectroscopic methods similar to those employed in his discovery of magnetic fields in sun spots, that the entire sun is a magnet, with a field about 80 times as intense as the magnetic field of the earth and with its magnetic axis inclined about six degrees to the sun's axis of rotation.

The Sun's Rotation.—As the light and heat which we receive from the sun are the source of all life on the earth, the important work is at once suggested to measure exactly how much radiant energy we receive from the sun in a given time, and especially, if possible, to find whether this is growing greater or less, or if it varies from time to time. Until so late as 1905 the measurements were comparatively very crude, but the sensitiveness of the instruments employed has recently been so increased and observations with them have been so carefully and continuously carried on that this quantity has now been well determined.

For measuring the amount of heat received on a square unit of the earth's surface, the so-called pyrheliometer is employed, an instrument which presents a surface of known area to the solar rays, the rise in temperature due to the heating being communicated to a stream of water (in the best form), and measured by an electrical thermometer. The unit usually employed is the calory, which is the amount of heat required to raise one gram of water 1° C. The *solar constant* is then the number of calories which would be received on each square centimeter of the earth's surface, exposed perpendicularly to the solar rays, if there were no loss in transmission through the atmosphere.

The following small table gives the mean values of the solar constant obtained from observations made at Washington, Mount Whitney and Mount Wilson. Observations were made at the second station, whose elevation is nearly three miles, in order to test the accuracy of the laws assumed for the absorption of solar rays by the atmosphere.

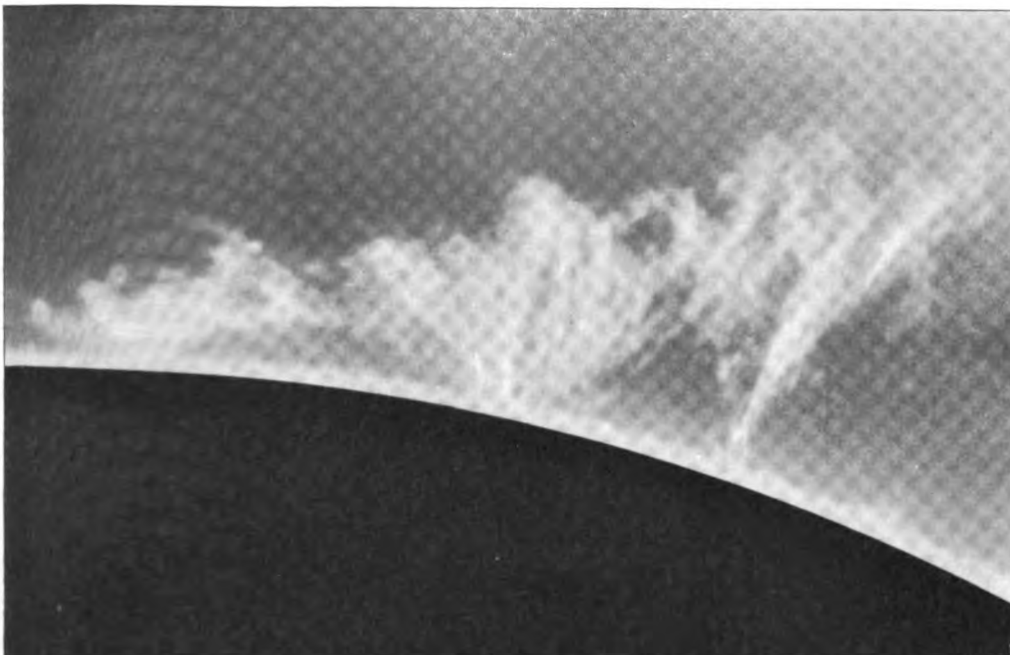
	Washington	Mount Whitney		Mount Wilson				
	1902–07	1909	1910	1905	1906	1908	1909	1910
Observations	44	1	3	52	62	113	95	28
Mean value	1.960	1.959	1.956	1.925	1.921	1.929	1.896	1.914

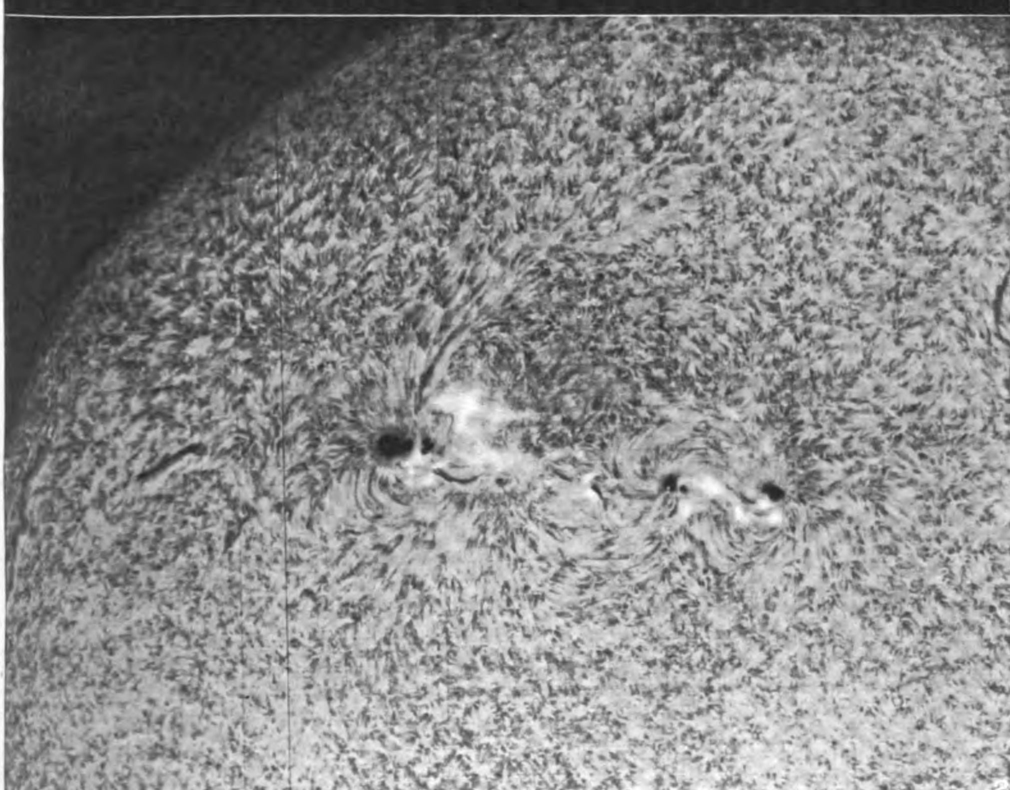
Prior to 1905 the true value of the constant was in much doubt; numbers ranging from 1.76 to 4.10 were stated for it, and the average value 3.0 was frequently accepted. There can be no doubt that the value 1.95 is very near the truth, and this may be regarded as the best value now obtainable. It has been well established, however, especially by the recent work of Abbot, that this fundamental constant varies slightly and irregularly. In 1919 a solar station was established at Calama, Chile, at which it is planned to make constant measures of the sun's radiation for several years, in conjunction with northern observations, with a special view of ascertaining, if possible, the law of this variation, and its effects upon terrestrial climates.

The Sun's Magnetism.— In the year 1908, Prof. G. E. Hale of the Mount Wilson Observatory, from an examination of the spectral lines in sun spots, discovered that around each spot there is a more or less powerful magnetic field. A powerful field will double many of the lines of the spectrum; a less powerful one will merely widen them. A few lines were found triple in sun spots, and afterward these same lines were found to become triple in the laboratory when viewed along the magnetic lines of force. Thus the lines of sun spots near the sun's limb tend to become triple, while those from spots near the centre of the solar disc are doubled merely. In many cases a pair of sun spots quite near together are found to have opposite polarity, and while in general the polarity of spots in the southern hemisphere is different from that in the northern, many cases of exception occur. It has, however, been well established that the sun, like the earth, has a north and south magnetic pole; the inclination of the sun's magnetic axis has been determined, and the fact has been established that the magnetic pole is in slow rotation about the pole of the sun.

A curious relation is found by the study of magnetic storms on the earth. The latter consist in occasional perturbations of the magnetic needle, which are very irregular in their character and are felt over the whole globe. They

SUN





1 Solar prominence 80,000 miles high, photographed with the spectroheliograph on Mount Wilson
2 The chromosphere and prominences photographed in projection against the sun's disk, showing the hydrogen vortices centering in sun-spots discovered at Mount Wilson

generally occur when there is an unusually bright aurora. Now, investigation shows that the number of these disturbances follows exactly the period of the solar spots. During those years when the spots are most numerous magnetic storms are most frequent, and vice-versa. The conclusion is that the sun spots and magnetic storms are due to the same cause. The sun's spots can be due only to something going on in the sun, and it follows that there must be some emanations from the sun which produce magnetic storms. Modern investigation has not been able to detect or define these emanations, though they are supposed to be electrically charged particles, shot out from the sun, and drawn in around the magnetic poles of the earth, where they give rise to the aurora. We have the strongest reasons to believe that neither the magnetic field of the sun as a whole nor the much more intense local fields in sun spots, produce any measurable magnetic effect at the distance of the earth.

Age and Duration of the Sun.— The greatest problem connected with the sun is suggested by modern science. Up to 100 years ago students and philosophers saw no reason why the sun should not continue to shed heat and light on the earth for an indefinite period without undergoing any change whatever. But toward the middle of the 19th century the laws of energy were developed and understood. These laws set forth that the radiation of heat always involves the expenditure of something called energy; and that the latter is necessarily limited in supply. It was also seen that the sun must be a hot body, and must lose all the heat it radiated. To make this subject clear, we must remark that what the sun really radiates is not properly called *heat* in scientific nomenclature; the more exact term is *radiant energy*. But this differs in no respect from what is radiated into a room from a hot fire. Radiant energy goes out from the fire and strikes the walls of the room, where it creates heat, and thus warms the walls. All the heat thus transmitted to the walls comes from the coal, although in its passage from the fire to the walls it passes through an intermediate stage called radiant energy. That the latter does not necessarily warm a medium through which it passes is shown by the striking experiment of making a large lens out of ice instead of glass. When the sun's rays are concentrated on a point by passing through this mass of ice they will burn the substance on which they fall, as if they had passed through glass. We see, then, that however cold the space between us and the sun may be, all the radiant energy reaching us from the sun must come from a source in the sun limited in supply.

If the sun were merely losing energy like an ordinary hot body cooling off, a very simple calculation will show that it would be so cooled off in the course of 3,000 or 4,000 years as no longer to radiate much heat. It is clear that such has not been the case. Yet the most careful study shows no possibility that it can be receiving any considerable part of its energy from any outside source. Moreover, the geologists assure us that the stratification of the rocks, as well as many other other phenomena associated with them, proves that the sun has been radiating heat to the earth at not much less than its present rate for hundreds of millions of years.

The only solution of the puzzle that was suggested until 1903 was based on the mutual convertibility of heat and motion. From the time that the theory of energy was developed it was known that when the motion of a material substance is arrested without any other effect being produced, heat is generated. For example, the waters of Niagara are warmed by about one-quarter of a degree Fahrenheit in striking the bottom of the falls. The blacksmith by hammering a piece of cold iron can make it hot, because the energy which he puts into the motion of the hammer is converted into heat when the latter strikes the iron. It follows that if bodies of any sort are falling into the sun, heat will be generated by the fall. Moreover, owing to the power of the sun's attraction, such bodies may fall with great velocity; and the heat thus generated increases as the square of the velocity. Thus arose the first theory as to how the sun's heat could be kept up. It was supposed that meteors were continually falling into that luminary. But further study showed it to be impossible that meteors could fall in such quantity as to have this effect.

Then it was suggested by Helmholtz and Thomson that if the sun were a gaseous body, as it is now supposed to be, radiating energy, the loss of the latter would continually be made up by the fall of its outer portions involved in the continual contraction of the sun through loss of heat. All bodies, and gaseous ones in a higher degree than any others, diminish in volume when they cool off. Accordingly, when the photosphere of the sun cools off, it diminishes in volume, grows smaller and falls down upon the mass of the sun below it. Careful calculation shows that if the sun contracted about 250 feet per annum, the energy thus generated would keep up all the heat which the sun radiates. An important addition to this theory was made by J. Homer Lane, who showed that if the sun contracted like a mass of pure gas it would continually grow hotter as it contracted. This is now known as Lane's law. But there is a necessary limit to the quantity of heat which can thus be generated. If the sun has been thus growing smaller through long ages, there must have been a time when it filled the whole space now occupied by the solar system. What is more, the contraction must have been far more rapid the larger the sun was; because the force of attraction at the sun's surface diminishes as the inverse square of the diameter of the sun. For example, when the sun was twice as large as it is now, this force was only one-quarter as great; consequently it would have to contract four times as much to generate a given amount of energy as it does now. Finally, exact computation showed that even on this theory there was still a limit to the existence of the sun too narrow to satisfy the demands of geology. It could not have been radiating heat for more than 50,000,000 or 100,000,000 years. Before that time it must, according to the theory, have been a gaseous mass filling the whole space now occupied by the solar system, which contracted and formed sun and planets, in accordance with the theory known as the "nebular hypothesis."

It also seemed very improbable that the sun's heat could have been at all constant for even 20,000,000 years; on the other hand, geologists went hundreds of millions of years. Thus apparently an irreconcilable contradiction was presented to scientific investigators when in 1900 the discovery of radium began to put a new face upon the fundamental theories of physical science. We now know that there is an immense amount of energy stored in the atom, which is a very complex thing. With the so-called «radioactive» substances, the atoms may be broken up, the result of the process being an element of lower atomic weight than the original substance. And in this breaking up of the atom a great amount of energy is liberated. Though it has been known for many years that Helmholtz' theory was inadequate, whether a large part of the sun's energy is of this sub-atomic origin, we do not know, but it is reasonable to suppose that it is. And it is only necessary to suppose that a part of the energy of the atom is in this way changed into heat energy to almost indefinitely prolong the life of the sun.

The most recent semi-popular, but authentic work is 'The Sun' by C. G. Abbot (New York 1911); this contains many references to more extended works or detailed publications. A larger and very important work is 'Physik der Sonne,' by E. Pringsheim (Leipzig 1910). Numerous papers will be found in the Proceedings of the Royal Society, London, and in the *Astrophysical Journal,* Chicago.

SIMON NEWCOMB.
Revised by ERIC DOOLITTLE.

SUN, Eclipses of the. See ECLIPSE.

SUN, Order of the. See ORDERS (ROYAL) AND DECORATIONS.

SUN-BIRDS, a large family (*Nectariniidæ*) of small insect-eating birds of the tropics of the Old World, having elongated, slender and curved bills, wings of moderate size and the central tail-feathers usually prolonged beyond the others. These birds occur in the Eastern Archipelago, India and Africa. They take the place of the humming-birds of the New World, and in brilliant coloration and habits much resemble these, but are far removed from them in classification, the honey-eaters (*Meliphagidæ*) being their nearest relatives. They are constantly hovering about flowers seeking the minute insects found within the petals and sipping the flower-juices, so that they have been named sucriers or sugar-eaters, by French authors. Some certainly eat fruits. The song is sweet, but without any special characteristics, and in habits they are exceedingly lively, quarrelsome and even pugnacious. The gaudy plumage is chiefly confined to the male sun-birds and depends for effect upon intensity of color and not upon metallic or prismatic lustre. The nests are built in the hollows of trees or are placed in thick bushes. Some species (such as *Nectarinia lotenia* and *N. asiatica*) make dome-like nests, which are suspended from the extremities of twigs of bushes, and are covered with cobwebs for the purpose of concealment. A magnificent treatise upon the sun-birds, with colored plates, has been written by Shelley, entitled 'A Monograph of the Nectariniidæ' (London 1876–80). The name is sometimes given to various other birds. Thus the sugar-birds or banana-birds (qq.v.) of the West Indies are often so called; and a large South American bird, also called finfoot, for which see HELIORNITHIDÆ.

SUN-BITTERN, an extraordinary somewhat rail-like bird of Brazil and Guiana (*Eurypgahelias*). It is about 16 inches long, body small and thin, neck long and slender, head like that of a heron, with a long, powerful beak compressed at the sides and slightly arched at the culmen; the plumage is minutely variegated with bars and spots of many colors, and it has the habit of spreading wings and tail in courtship or on other occasions of excitement, forming a rosette about its head and neck fancifully compared to a «sunburst.» It is often made a pet by the Brazilians, who call it peacock. A larger species (*E. major*) inhabits Venezuela and Colombia. Their nearest relative is the kagu (q.v.). Consult Newton, A., 'Dictionary of Birds' (New York 1893–96).

SUN CRACKS. See MUD CRACKS.

SUN-DANCE, a ceremony performed, with local variations, by most of the prairie Indians, including the Mandan, Omaha, Pawnee Loup, Cheyenne, Arikara, Hidatsa, Blackfeet, Nez Percé, Winnebago, Yankton, Santee and Kiowa. It is held apparently at the full moon occurring at or next after the summer solstice, and lasts from three to six days. The budding of the wild sage also indicates the times for holding the ceremony, and all neighboring tribes, whether friendly or not, are usually invited. The dance begins at sunrise and ceases at the following sunrise. As may be inferred from the length of the festival, including the fasting and purification of the devotees and other preparatory acts, the actual sun-dance is but the chief episode in a ritual comprising a congeries of ceremonies. The motive or purpose of the dance is to promote welfare through the gratification of desires and wants and to avoid ill-fare through the dispelling of hostile agents. The devotee or sun-dancer indulges in the ceremony to fulfil a vow, made by him during the previous winter or season from various motives, that he would make a prayer to the disposer of what he needs through an appeal to the sun, to «Wakanda» (among the Sioux). The Tetons call the ceremony by a name which means «They dance looking at the sun.» In it the moon is regarded as the representative of the sun, hence the dancers gaze at it just as they do at the sun. Among the principal objects in the festival of the sun-dance is the sun-pole or «mystery tree» (symbolic of the centre of the four quarters of the heavens), the sacred tent of preparation erected within the so-called camping-circle of the tribe, wild sage, a sweet-smelling grass called *wachañga* by the Teton and the dancing-lodge. Each devotee persists in his part until he has received a vision from the sun; but if at the close of the ceremony no such vision has been vouchsafed to him, resort is had to self-sacrifice, which is called «vision-hunting.» One of the characteristic forms of self-sacrifice is that of having two wooden skewers inserted underneath strips of skin raised by slashing the breast or back, to which stout thongs are made fast, by which the devotee is drawn up and fastened to the sun-pole, to which he remains suspended until his weight, sometimes made greater by having a buffalo-skull hung to his person by similar skewers, causes the latter to rend the skin, thus letting the devotee fall to the ground, usually in a faint; another may have a buffalo-skull suspended from thongs passing through raised strips of the skin on the back or breast, which is allowed to hang thus until the skin is parted by violence and the thongs are freed. Some men who do not intend to dance seat themselves near the sun-pole, and small pieces of flesh are cut out in a row from the shoulders of each; these are offered to the being represented by the sun-pole. Women do not scarify themselves in the sun-dance, and self-torture and the shedding of blood are not practised in the Kiowa ceremony. Consult Catlin, G., 'North American Indians' (new ed., 2 vols., Philadelphia 1913); Lowrie, R. H., 'The Sun Dance of the Crow Indians' (New York 1915).

SUN-DEW, any herb of the genus *Drosera*, which is classified near the pitcher-plants and the roses. Several species are found in America. The flowers are very pretty, like that of the saxifrage, five-petaled, and borne at the top of a leafless scape, in a raceme, the buds in which are bent downward, the blossom of each day surmounting the arch and facing the sky. They are white or purplish in color. Sundews grow in bogs or wet ground, the roots are poorly developed and yet the small plants thrive even in sphagnum; this is because they are flesh-eaters, and live on the nutriment obtained from such insects as they can catch on their foliage; the roots, therefore, serving principally to anchor the plants and to supply the large amount of water needed. The leaves, varying in shape in the several species, from round to filiform, are covered thickly on the upper face with wine-red filaments having a glistening drop like dew at the tips. These are stalked glands, destined for a purpose as deadly as that of the tentacles of the octopus. The leaf blades of the *Drosera rotundifolia*, a common sun dew, are round, and are arranged in a rosette around the base of the flower-scape, the smooth green under surfaces resting on the ground. In times of inaction the tentacles radiate in concentric circles and are tipped by their globular translucent glands, which sparkle with a viscid secretion exuded by them. But let a fly light on one of the glands and remain there, glued fast by the viscous fluid, and there is immediately a change in the state of things. In its efforts to release itself, the struggling insect is only besmeared more completely, chokes the organs of respiration and is ultimately smothered. In the meantime, the tentacles, disturbed by the fly, have become excited and have transmitted the stimulus to the other glands so that they all bend toward the tiny body, converging over it, and striving to touch it. They even shift the inert object toward the centre of the leaf-blade, so that the greatest number of tentacles may reach it. Such glands as succeed in touching the meat secrete an acid juice, with the addition of a ferment which is entirely similar to pepsin, and apply this secretion to the fly, digesting it, as it were. The glands then absorb the flesh and blood of the meat, and also their own secretions. The tentacles straighten up, the undigested portions of the insect resting on the dry glands are blown away, and the glands soon begin to exude their viscid secretion again, and make themselves ready for a fresh victim. When a large insect is entangled, the leaf-blade itself folds inward slightly, so that a maximum number of tentacles may concentrate upon the food. *D. filiformis* has erect, very narrow leaves, and when an insect is caught by the glands, the leaves themselves bend toward it. In *D. longifolia* the leaf-blade enfolds the fly. Sun-dew glands respond by bending to repeated touches, although no object rests upon them. It is only nitrogenous food which is obtained by this digestive process; carbonic acid is assimilated from the air as by other plants. Consult Darwin, C., 'Insectivorous Plants' (1875; new ed., 1900).

SUN-DIAL, an hour-measuring instrument known from the earliest times to the Egyptians, the Chaldæans and the Hebrews. It is worthy of remark, however, that no ancient Egyptian sun-dials have been found. Those connected with Egyptian remains have been recognized as all of Greek origin. The Greeks adopted it from their Eastern neighbors, and it was introduced into Rome during the First Punic War. One of the earliest types of sun-dial found in Egypt, and still in use there, consists of a palm rod set upright in the ground, with a circular arc around it set out with stones to mark the hours as the shadow of the rod traverses the circle. Another more primitive form still in existence in Egypt has a rod laid horizontally in a north-and-south direction on two forked uprights, a short distance above the ground. At equal distances east and west of the rod are placed two stones or pegs. When the shadow of the rod lies across the westerly peg the day's work begins; when it reaches the easterly peg the day's work is ended.

It was discovered in very early times that a vertical rod could not throw a shadow that would accurately denote time, and the correct inclination of such a rod or the stile of a sun-dial was evidently a matter of experiment and approximation before the ancient astronomers fixed the angle by calculation. This surmise is borne out by the various inclinations found in ancient dials. Some of these were constructed arbitrarily at 45°, an angle having no relation whatever to the latitude of its location.

The first historic sun-dial dates from about 1000 B.C. It was found in Rhodesia, and is believed to be of Semitic origin. Sun-dials are referred to in Grecian literature in 560 B.C., and a certain sun-dial is specifically spoken of as having been set up at Athens by the astronomer Meton in 433 B.C. It is said of the Turks that wherever they build a mosque they place a sun-dial. In China they are everywhere, and small ones which may be carried in the pocket are very common. The correct use of these portable dials depends, of course, upon their accurate orientation when reading them.

Sun-dials have been classified under three headings, according to their superficial form: spherical, cylindrical and plane. The spherical form is the most ancient. It consists of a hemispherical hollow cut into a rock or built up in that form, the flat of the hemisphere being horizontal. An upright rod was set in the centre of the hemisphere, pointing to the zenith. The hour marks were cut into the hollow surface. A variation of this type was the cutting away of the front half of the hemisphere. This form of necessity can mark only the hours from 6 A.M. to 6 P.M. An old Roman dial is in the form of a spherical shell of which about two-thirds have been cut away, held upon the shoulders of a herculean figure. Cylindrical dials have the hollow in the shape of a semi-cylinder cut through lengthwise. A rod in the position of the axis of the cylinder throws the shadow. A variation of this form is a semi-cone cut through its axis. The plane dials are too well known to need description.

In the placing of sun-dials another classification comes into play; they may be horizontal or vertical. Many of the latter type are set into or carved upon the walls of churches or other buildings or on stone blocks set upon pillars or pedestals. As a rule, the vertical sun-dials are set to face directly south. Where this is not feasible the gnomon may extend toward the south at the angle of a corner of a building, the hour lines being partly on one façade and partly on the other. In some of the odd pillar types the stone block at the top is cut with many facets like a crystal, with a gnomon on each facet.

The leading principles of dialing may be made intelligible to general readers by the following simple illustration:

Let P B *p* D represent the earth as a hollow transparent sphere, having an axis P E *p*, of

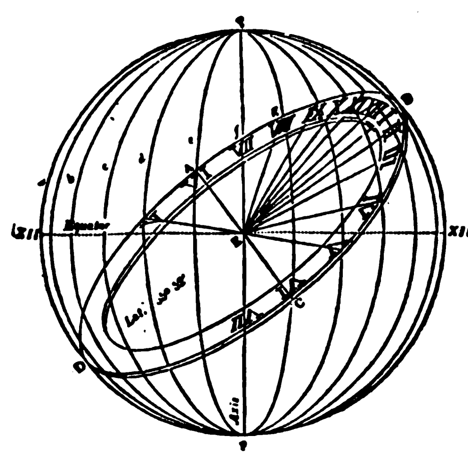


FIG. 1.

which P and *p* are the poles. Let the equator be divided into 24 equal parts and through these divisions draw the meridians, *a*, *b*, *c*, *d*, etc. Let one of these meridians pass through any given place for which a dial is required to be made, and where that meridian cuts the equator let it be numbered XII. The opposite meridian must likewise be numbered XII, the other meridians being numbered as shown in the cut. This being done, these meridians will be the hour circles of the place on the first meridian; so that if the axis P E *p* were opaque, the sun in his (apparent) motion round the earth in 24 hours will pass from one meridian to another in one hour, and cause the shadow of the axis to fall on the hour on the plane D C B A. This diagram has been drawn for the latitude of Glasgow, 55° 52′, and the plane in its present position would form a horizontal dial for that place; but we may suppose it capable of moving round its axis A C, so as to assume different positions

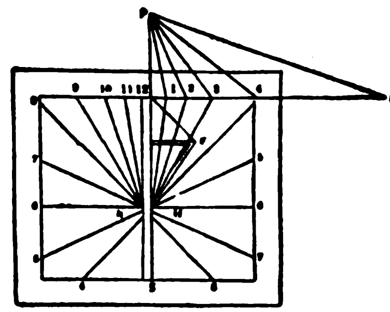


FIG. 2.

in the sphere. If it move round so as to become vertical, that is, at right angles to its position in the figure, we then obtain an erect south dial. The plane may also be made to incline from the meridian either toward the east or west. Thus we have dials of different kinds dependent on the position of the plane with regard to the first meridian, the position of the hour lines of which are all determined by the meridians of the sphere cutting the plane.

We have been considering the earth as the sphere, in our illustration of the nature of dials, but the earth's magnitude is so small compared with the distance of the sun, that no appreciable error will follow in considering a small glass sphere similar to that above described, but placed on the surface of the earth with its axis parallel to that of the earth; then will the sphere show the hour of the day in the manner before specified. The only things absolutely essential for a dial are the axis and the plane, the places of the hour lines having been once determined. Dials may have various forms, many of which are exceedingly curious and intricate, and require for their construction the application of complicated trigonometrical formulæ. We shall confine our attention here to the most common, and, at the same time, most useful form, that is, the plane horizontal dial. On the proposed plane, which may be either of marble, slate or brass, draw a straight line P H S for the meridian or 12 o'clock line, and parallel to this draw 12, h S, leaving a space between them equal to the thickness of the gnomon. The gnomon is a thin triangular plate of metal, somewhat similar in shape to the figure A E B, the side A B being fixed into the plate of the dial, so that the gnomon shall stand perpendicularly, the line A E being directly north and south.

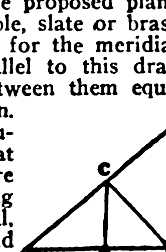


FIG. 3.

The line A E is called the style, and the angle E A B is made equal to the latitude of the place for which the dial is constructed. In the case of a vertical dial the angle E A B must be the complement of the latitude, the line A B the top of the gnomon and the line B E affixed to the dial.

We return again to the consideration of Fig. 2. Draw 6 H 6 perpendicular to 12 H S, and it will be the six o'clock hour line; make the angle 12 H F equal to the latitude of place, and draw 12 F perpendicular to H F; continue S 12 to P, making 12 P equal to 12 F. The line 12 1 2 3 4 is drawn parallel to the line 6 H 6. From the point P draw the lines P 1, P 2, P 3, etc., terminating in the line 12 1 2 3 4, making angles with the line 12 P at the point P of 15°, 30°, 45°, etc., increasing by 15° each line. Next from the centre H draw the lines H 1, H 2, H 3, etc., and thus the hour lines of 1, 2, 3, 4 and 5 P.M. will be found. The hour lines on the other side of the style should now be formed by taking a tracing of the side already formed; the hours are of course numbered differently, and both sides will stand thus, the hour line of both sides corresponding:

1, 2, 3, 4, 5, 6, 7, 8,
12,
11, 10, 9, 8, 7, 6, 5, 4.

Here we have carried the hours beyond 6, which was the extent of the construction but to find the hour lines for 4 and 5 in the morning we have only to produce the hour lines of 4 and 5 in the evening, and in like manner for the hour lines of 7 and 8 in the afternoon, produce the hour lines of 7 and 8 in the morning. The dial gives solar time, and, therefore, the time, according to it, will only agree four days in the year with a well-regulated clock. See EQUATION.

The orientation of the sun-dial after it is made is a necessity of the first importance if satisfaction is desired. This process is carried out usually at night with the aid of two plumb-lines one north and the other south of the position in which the dial is to be set. From the Nautical Almanac the time is found at which the polestar crosses the meridian of the place. The two plumb lines are brought into a line pointing to the star at that moment. The dial can then be placed in the same line conveniently by daylight. It is usual to erect frames of considerable height to hold the plumb-lines so that the sighting upward may be the easier. If the location of the pedestal of the dial is chosen beforehand, the frames for the plumb-lines must be so arranged that both may be moved so as to have the centre of the pedestal in the same line with them and the star.

The sun-dial is daily getting more rare in this age but notwithstanding the superiority of the clock, why has the dial almost everywhere vanished? "If its business use," as has been well observed, "be superseded by more elaborate inventions, its moral use, its beauty, might have pleaded for its continuance. It spoke of moderate labors — of pleasures not protracted after sunset — of temperance and good hours. It was the primitive clock — the horologue of the first world. Adam could scarce have missed it in paradise. It was the measure appropriated for sweet plants and flowers to spring by — for the birds to apportion their silver warblings by — for flocks to pasture and be led to fold by. The shepherd carved it out quaintly in the sun, and, turning philosopher by the very occupation, provided it with mottoes more touching than tombstones."*

Bibliography.— Denison, E. B., 'Clocks, Watches and Bells' (London 1860); Gatty, Mrs. A., 'The Book of the Sun Dial' (London 1900); Hogg, W., 'The Book of Old Sundials' (London 1917); Horner, E., 'Primitive Sun-Dials or Scratch Dials' (Taunton, England 1917); Leybourn, W., 'Dialling' (London 1700); Wells, I., 'Sciographia: or the Art of Shadows' (London 1635).

SUN-DOG, also called **MOCK-SUN** and **PARHELION**. *In meteorology*, a bright, luminous area sometimes seen on either side and at the same altitude as the sun. Sun-dogs are found at the points in which the solar halos cut the horizontal, parhelic circle. Thus two sun-dogs are usually seen on either side of the sun, and at equal distances from it, though four are not infrequent. The nearer pair are 22° from the sun and the outer are 46° distant, while fainter sun-dogs are more rarely seen at 50°, 98° and 120°, and even directly opposite the sun, at 180°. The last is sometimes known as an *Anthelion*.

Bright areas formed at the intersections of any two circular halos near the sun are sometimes also referred to as sun-dogs and such sometimes are seen directly above and below the sun. The parhelic circle is produced by the reflection of the sun's light from ice prisms or snow crystals whose axes lie in a vertical position: so-called "Contract Arches" arise from prisms whose axes are horizontal. It is the latter that give rise to sun-dogs which are vertically above and below the sun.

Sun-dogs are usually reddish on the sides toward the sun and they are sometimes greatly elongated along the parhelic circle which produces them. They vary greatly in brightness and distinctness with the variation of the number and arrangement of the ice crystals in the air.

SUN AND LION, Order of, a Persian order founded in 1808 by Shah Fath Ali, in imitation of the French Legion of Honor, established about six years previously by Napoleon I, then first consul. It includes five classes.

SUN MOTOR. See SOLAR MOTOR.

SUN WORSHIP, a form of nature worship which prevailed in all the ancient civilizations. In numerous primitive religions the sun is not the supreme deity: in many the moon holds the pre-eminence. The mode of reckoning time by moons is more ancient than solar calculation: in the language of the Hottentots, just as in Teutonic, the Moon is "he," the Sun "she"; and rude tribes in both hemispheres still make the moon masculine, the sun feminine: the ancient Germans used to say Hermon (*herrmond*, Lord Moon) as the Germans still say Herrgott: on the other hand, as a mediæval writer tells us, the sun used to be called "Holy Lady": "I knew an old woman who believed the sun to be a goddess, calling her *sancta domina*." The aborigines of North America worship the sun; for them the peace-pipe is the gift of the sun; in the council the pipe is always passed

* "*Horas non numero nisi serenas*" ("I count not the hours unless they be bright") was an ancient dial motto of great beauty and significance.

around, following thus the sun's course. The Natchez lived under a monarchy and the royal family, children of the Sun, like the race of the Incas of Peru, stood high above the common people. In Mexico the sun was pre-eminent over all the other gods. In the Hebrew sacred books there are solemn denunciations of sun worship, for the heathen all around paid adoration to that luminary; and it is clear from 2 Kings xxiii, 5, 19, that some of the kings both of Judah and of Israel favored the worship of the sun.

SUN-YAT-SEN, Chinese revolutionary leader: b. Fatshan, near Canton, 1866. He was graduated (1892) at Hongkong School of Medicine, and started practice at Macao when he became one of the plotters resolved on forcing the Manchu dynasty from power. He fled from Canton after the first failure at revolt and went to Japan, thence to San Francisco. He formed the revolutionary association *Kao Lao Hwei* and carried on his propaganda all over the world, making the United States his headquarters and domicile. Dr. Sun's life was jeopardized by the standing reward of $50,000 for his assassination, but the revolution of 1911 in China succeeded, thanks largely to his indefatigable energy and resourcefulness in propagating the work in every country. He was rewarded by being made Provisional President of the new Chinese Republic but resigned in 1912 in favor of Yuan Shih-kai in order to bring the great Northern influence of the latter into the cause. Sun's later opposition to Yuan Shih-kai in the Peking Parliament caused his expulsion and he had to flee to Japan. Consult Cantlie and Jones, 'Sun-Yat-Sen and the Awakening of China' (3d ed., New York 1913).

SUNBURN (erthema solare or eczema solare), an injured condition of the skin caused by exposure to the action of the heat of the sun's rays. The resulting conditions vary according to the degree of elevation of the temperature, the character of the medium through which its effect is exerted, length of time the skin is subjected to the action. The effect is productive of an erythmatous redness, skin slightly tumified (swollen), with sensation of burning heat. In its course the skin usually desquamates (scales off) and becomes the seat of a "dirty-brownish stain," which passes off later. Such a condition is brought about by several hours' exposure of the bare skin to the sun's rays. Under severe conditions of temperature blistering may arise at times. In the former, ordinary cases a lotion or salve excluding the air from the injury, and to relieve the pain, is applied. Zinc oxide, boric acid, vaseline, etc., are recommended. In severer cases where blistering arises the same treatment must be used as in scalds or burns.

SUNBURY, sŭn'bŭ-rĭ, Pa., borough, county-seat of Northumberland County, on the Susquehanna River, and on the Pennsylvania and the Philadelphia and Reading railroads, about 157 miles north of Philadelphia and 55 miles north of Harrisburg. It was settled in June 1772 by Surveyor-General Lukens and William Maclay. It was incorporated as a borough 24 March 1797. The place was once the site of the Indian village of Shamokin. In 1756 Fort Augusta was erected here as a means of defense against the French and Indians. The city is in a lumbering and coal region. The chief manufacturing establishments are railroad shops, planing mills, silk mills, dye works, sash and door factories, nail factories, a rolling mill and coffin and casket works. It is an important commercial and industrial centre for a large region; extensive coal shipments are made from here. The principal public buildings are the county courthouse, municipal buildings, the Mary M. Packer Hospital, the churches and public schools. The three banks have a combined capital of $500,000. The government is vested in a chief burgess and a council of 18 members, who hold office two years. A small stream separates Sunbury and East Sunbury; the boroughs are one in industrial and commercial interests, but have independent municipal governments. Pop. about 16,000.

SUNDA (sŭn'dạ) **ISLANDS,** a group of islands in the Indian Ocean, comprising three minor groups, namely, (1) the Great Sunda Islands, to which belong, Sumatra, Borneo, Celebes, Java, Madura, Banka and Billiton; (2) the Lesser Sunda Islands, comprising nine islands of smaller extent, and (3) the Timor Group, all forming part of the Malay or East Indian Archipelago. The flora is exceedingly rich and varied. This is the home of sugar-cane and many of the spices, and the different altitudes from coasts upward produce an exceptional variety of plant-life. Some districts, as in Sumatra, reach high elevations, others consist chiefly of grassy plains, or forest-covered slopes.

SUNDA STRAIT, East Indies, the channel which separates the island of Java from Sumatra. It is from 20 to 100 miles wide, and contains a number of volcanic islands, the most noted of which is Krakatoa (q.v.). The strait is an important commercial channel.

SUNDARBANS, soon'där-bạnz, or **SUNDERBUNDS,** soon'dėr-bŭndz, India, the alluvial islet region lying around the mouths of the Ganges River (q.v.), and forming the lower part of the delta. It stretches for 175 miles along the coast, and has an area of 8,000 square miles. The region is intersected by a network of innumerable channels and backwaters, many of which are navigable. The intervening islands are largely marshy, and covered with dense forest jungle abounding in wild animals, snakes, crocodiles, tigers and leopards. The unhealthful climate has hitherto defeated all attempts at reclamation.

SUNDAY, William Ashley, American evangelist: b. Ames, Iowa, 19 Nov. 1863. He was educated at the high school, Nevada, Iowa, and studied at Northwestern University. From 1883–90 he was a professional baseball player in the Chicago, Pittsburgh and Philadelphia teams of the National League. He became assistant-secretary Y. M. C. A at Chicago (1891–95) and started his career as evangelist in 1896. In 1903 he was ordained a Presbyterian minister by the Chicago Presbytery. He has held evangelistic meetings in many of the cities of the United States, drawing large audiences and securing great numbers of converts.

SUNDAY, the Christian weekly festival, by theologians associated with the Jewish Sabbath (see SABBATH), while its observance is often enforced by the citation of the Fourth Commandment in the Decalogue. While the Christian Church has never identified Sunday with the Jewish Sabbath, it has always quoted the Fourth Commandment as sanctioning, if not enacting, rest and relaxation from labor in one day out of every seven. When the Church was made a department of the state by the Christian emperors of Rome, the observance of Sunday was enforced by civil statute. When the Roman Empire passed away, and the office of pontifex maximus, once held by the emperor of Rome, was claimed by the bishop of Rome, Sunday observance was enforced by ecclesiastical as well as civil law. The Third Council of Orleans 538 forbade all rural work on Sunday. Pope Gregory I made at Rome the same law as had been passed in 578 by the Council of Auxerre: "On the Lord's Day it is not permitted to yoke oxen or to perform any other work, excepting for approved reasons." Charlemagne in 813 enacted that on the Lord's Day all servile labor should be abstained from.

By the laws that obtained in England during the Saxon monarchy up to the time of Edward the Confessor (whose Sunday law is dated 1056), abstention from marketings on Sunday and from popular meetings was enforced under penalty of a fine. Equally strict was the Sunday legislation which followed the Norman Conquest. The mediæval Sunday laws in England were but the expansion of the Saxon laws. In 1281 A.D. John Peckham, archbishop of Canterbury under Edward I, explained the Fourth Commandment as follows:

"In the commandment 'remember that thou keep holy the Sabbath day,' Christian worship is enjoined, to which laymen as well as clerks are bound; and here we are to know that the obligation to observe the legal Sabbath, according to the form of the Old Testament, is at an end, together with the other ceremonies in that; to which in the New Testament hath succeeded the custom of spending the Lord's Day, and other solemn days appointed by the authority of the Church, in the worship of God; and the manner of spending these days is not to be taken from the superstition of the Jews, but from the canonical institutes."

A statute of the 28th of Edward III runs as follows: "Item, it is accorded and established, that showing of wools shall be made at the stable every day of the week, except the Sunday and solemn feasts of the year."

In 1359 A.D. Islep, archbishop of Canterbury, issued the following to his clergy: "Whereas, the most excellent prince, our lord, the King of England, is now going to make an expedition in foreign parts with his army for the recovery of his right, exposing himself as a soldier to the doubtful events of war, the issue whereof is in the hand of God; we who have hitherto lived under his protection are, by the divine favor shining on us, admonished to betake ourselves to prayer, as well for the safety of every one of us as for the public good, lest if adverse fortune should invade us (which God forbid), our confession and reproach should be the greater. But, though it is provided by sanctions of law and canon that all Lord's days be venerably observed from eve to eve, so that neither markets, negotiations or courts, public or private, ecclesiastical or secular, be kept, or any country work done on these days, yet we are clearly to our heart's grief, informed that a detestable, nay, damnable perverseness has prevailed, insomuch that in many places markets not only for victuals, but other negotiations (which can scarce be without frauds and deceits), unlawful meetings of men who neglect their churches, various tumults and other occasions of evil are committed, revels and drunkenness, and many other dishonest doings are practised, from whence quarrels and scolds, threats and blows and sometimes murder proceeds on the Lord's days, in contempt of the honor of God; insomuch that the main body of the people flock to these markets, by which the devil's power is increased; whereof we strictly command you, our brother, that ye, without delay, canonically admonish and effectually persuade, in virtue of obedience, or cause to be admonished and persuaded, those of your subjects whom you find culpable in the premises, that they do wholly abstain from markets, courts, and other unlawful practices above described, on the Lord's days for the future; and that such of them as are come to years of discretion, do go to their parish churches to do, hear and receive what the duty of the day requires of them; and that ye restrain all whatsoever that transgress and rebel in this respect, both in general and particular, with Church censures according to the Canon."

The 27th statute of Henry VI is as follows: "Item, considering the abominable iniquities and offenses done to Almighty God and to his saints, always aiders and singular assisters in our necessities, because of fairs and markets upon their high and principal feasts, as in the feasts of the Ascension of our Lord, in the day of Corpus Christi, in the day of Whitsunday, in Trinity Sunday, with other Sundays, and also in the high feast of the Assumption of our Blessed Lady, the day of All Saints, and on Good Friday, accustomably and miserably holden and used in the realm of England: in which principal and festival days for great earthly covetise, the people is more willingly vexed, and in bodily labor foiled, than in other ferial days, as in fastening and making their booths and stalls, bearing and carrying, lifting and placing their wares outward and homeward, as though they did nothing remember the horrible defiling of their souls in buying and selling, with many deceitful lies and false perjury with drunkenness and strifes, and so specially with drawing themselves and their servants from divine service; the aforesaid lord the king, by advice and assent of the lords spiritual and temporal and the commons of this realm of England, being in the said Parliament, and by authority of the same Parliament, hath ordained that all manner of fairs and markets in the said principal feasts and Sundays and Good Fridays, shall clearly cease from all showing of any goods and merchandise (necessary victual only excepted) upon pain of forfeiture of all the goods, aforesaid so showed."

In 1464 A.D., under Edward IV, an addition was made to the act of Henry VI, of 1448 A.D., declaring that — "Cobblers and cordwainers in the city of London, or within three miles thereof, excepting within the precincts of Saint Martinsle-Grand and the palace at Westminster, were forbidden on any Sunday in the year, or on the feasts of the Nativity or Ascension of our

Lord, or on the feast of Corpus Christi to command or cause to be sold, or place or put on any one's feet or legs, any shoes, hose or galoches, under the penalty of the forfeiture of the article and a fine of twenty shillings for every offense; a third part to go to the king, a third to the governors of the guild (mestier) of cordwains, and the residue to the informer.»

In 1523 this act was repealed by Henry VIII (15th Henry VIII, ch. ix).

On coming to the throne in 1547, Edward VI issued the following injunctions: «Whereas in our time, God is more offended than pleased, more dishonored than honored, upon the holy day (Sunday), because of idleness, pride, drunkenness, quarreling and brawling, which are most used in such days; people nevertheless persuading themselves sufficiently to honor God on that day if they hear mass and service, though they understand nothing to their edifying; therefore all the king's faithful and loving subjects shall from henceforth celebrate and keep their holy day (Sunday) according to God's holy will and pleasure, that is in hearing the Word of God read and taught, in private and public prayers, in acknowledging their offenses to God, and amendment of the same, in reconciling theirselves charitably to their neighbors, where displeasure hath been, in oftentimes receiving the communion of the very body and blood of Christ, in visiting the poor and sick, and in using all soberness and godly conversation.»

Elizabeth put forth the following injunction touching Sunday: «All the queen's faithful and loving subjects shall, from henceforth celebrate and keep their holyday according to God's will and pleasure; yet notwithstanding, all parsons, vicars and curates shall teach and declare unto their parishioners, that they may with a safe and quiet conscience, after their common prayer in the time of harvest, labor upon the holy and festival days, and save that thing which God hath sent . . . in every parish three or four discreet men, which tender God's glory, and his true religion, shall be appointed by the ordinaries diligently to see, that all the parishioners duly resort to their church upon all Sundays and holy days, and there to continue the whole time of the godly service; and all such as shall be found slack and negligent in resorting to the church, having no great or urgent cause of absence, they shall straightly call upon them, and after due admonition if they amend not, they shall denounce them to the ordinary.»

Under the Puritan influences attempts were made to bring about a too strict observance of Sunday. To counteract this Charles I republished an injunction issued by his father, James I, in which he declared: «As for our good people's lawful recreation, our pleasure likewise is, that after the end of divine service our good people be not disturbed, letted or discouraged from any lawful recreation, such as dancing, either men or women, archery for men, leaping, vaulting or any other such harmless recreation, or from having May games, Whitsonales and morris dances, and the setting up of May poles and other sports therewith used, so as the same be had in due and convenient time without impediment or neglect of divine service; and that women shall have leave to carry rushes to church for the decorating of it, according to their old custom. But withal we do here account still as prohibited all unlawful games to be used on Sundays, only as bear and bull baitings, interludes, and at all times in the meaner sort of people by law prohibited bowling.»

The act of Charles II (1676) was the law of the American colonies up to the time of the Revolution, and so became the basis of the American Sunday laws. It runs as follows:

«For the better observation and keeping holy the Lord's day, commonly called Sunday: be it enacted by the king's most excellent majesty, and by and with the advice and consent of the lords, spiritual and temporal, and of the commons in this present Parliament assembled, and by the authority of the same, that all the laws enacted and in force concerning the observation of the day, and repairing to the church thereon, be carefully put in execution; and that all and every person and persons whatsoever shall upon every Lord's day apply themselves to the observation of the same, by exercising themselves thereon in the duties of piety and true religion, publicly and privately; and that no tradesman, artificer, workman or other person whatsoever, shall do or exercise any worldly labor or business or work of their ordinary callings upon the Lord's day, or any part thereof (works of necessity and charity only excepted), and that every person being of the age of fourteen years or upwards offending in the premises shall, for every such offense, forfeit the sum of five shillings; and that no person or persons whatsoever shall publicly cry, show forth, or expose for sale any wares, merchandise, fruit, herbs, goods or chattels whatsoever, upon the Lord's day or any part thereof, upon pain that every person so offending shall forfeit the same goods so cried or showed forth or exposed for sale.» «And it is further enacted that no drover, horse-courser, wagoner, butcher, higgler — they or any of their servants shall travel or come into his or their inn or lodging upon the Lord's day, or any part thereof, upon pain that each and every such offender shall forfeit twenty shillings for every such offense; and that no person or persons shall use, employ, or travel upon the Lord's day with any boat, wherry, lighter or barge, except to be upon extraordinary occasion to be allowed by some justice of the peace of the county, or some head officer, or some justice of the peace of the city, borough or town corporate, where the deed shall be committed, upon pain that every person so offending shall forfeit and lose the sum of five shillings for every such offense.»

The Lord's day legislation of Cromwellian days was as distinct and detailed as a fragment from Leviticus, as is shown in the following extract from an act of Parliament dated 1656: «Every person grinding or causing to be ground any corn or grain in any mill, or causing any fulling or other mills to work upon the day aforesaid; and every person working in the washing, whiting or drying of clothes, thread or yarn, or causing such work to be done, upon the day aforesaid; every person setting up, burning or branding beet, turf or earth, upon the day aforesaid; every person gathering of rates, loans, taxations or other payments upon the day aforesaid (except to the use of the poor in the public collections); every chaundler melting, or causing to be melted, tallow or wax belonging to his calling; and every common brewer and baker, brewing and baking, or causing bread to be baked, or beer or ale to be brewed upon the day aforesaid; and every butcher killing any cattle, and every butcher, coffermonger, pouiterer, herb seller, cordwayner, shoemaker or other persons selling, exposing or offering to sell any their wares or commodities, upon the day aforesaid; all taylors and other tradesmen, fitting or going to fit, or carry any wearing apparel or other things; and barbers trimming upon the day aforesaid; all persons keeping, using or being present upon the day aforesaid at any fairs, markets, wakes, revels, wrestlings, shootings, leaping, bowling, ringing of bells for pleasure or upon any other occasion (saving for calling people together for the public worship), feasts, church ale, Maypoles, gaming, bear-baiting, bull-baiting, or any other sports and pastimes; all persons unnecessarily walking in the church or church-yards, or elsewhere in the time of public worship; and all persons vainly and profanely walking, on the day aforesaid; and all persons traveling, carrying burthens or doing any worldly labor or work of their ordinary calling on the day aforesaid, shall be deemed guilty of profaning the Lord's day.»

In the 17th century a number of dissenters fled from England and reached America in 1620, and settled at New Plymouth. In 1629 another band from England joined them. Thus the establishment of Puritanism in America. The theocracy of the Hebrews furnished the model after which their civil government was constituted. Their idea of Sunday is summed up in the enactment of 10 June 1650, passed by the Plymouth general court: «Further be it enacted, that whosoever shall profane the Lord's day by doing any servile work, or any such like abuses, shall forfeit for every such default ten shillings, or be whipped.» Profanation of the Lord's day included traveling, loitering at the door of a meeting house, drinking in an inn, staying at home instead of attending church and it was also enacted by the court, that «if any in any lazy, slothful or profane way doth neglect to come to the public worship of God. shall forfeit for every such default ten shillings, or be publicly whipped.»

In Massachusetts the laws were equally strict.

In 1716 Sunday desecration appears to have been on the increase, since we are told: «Many persons do presume to work and travel on the said day»; so that the authorities saw fit to increase the penalty for «working or playing» to 10 shillings, and that for traveling to 20 shillings for the first offense. For the second offense these fines were doubled and the parties made to give «sureties» for good behavior in the future. A month's continued absence from the public Sunday services was also made finable in the sum of 20 shillings, or three hours in the stocks or cage. In 1727, the fine for «working or playing» was increased to 15 shillings, and that for traveling to 30 shillings for the first offense, and for the second, three pounds. If the offender failed to pay, he was liable to the stocks or the cage for four hours, or to imprisonment in the county jail not to exceed five days. At this time, also, funerals, since they induced «great profanation» of Sunday, by the traveling of children and servants in the streets, were prohibited, except in extreme cases, and then under license from a civil officer of the town. The director of a funeral transgressing this was to be fined 40 shillings, and the sexton or grave-digger 20 shillings. Shops for the retailing of strong drinks were also to be searched by the proper officers, and if any were found there drinking, the proprietor and the drinker were each to pay five shillings.

In 1760 all former laws relative to Sunday gave way to a new code, the provisions of which were as follows: Work or play, on land or water, is fined not less than 10 nor more than 20 shillings. Traveling by any one except in extremity and then only far enough for immediate relief, is liable to the same penalty. Licensed public-house keepers are forbidden to entertain any except «travelers, strangers and lodgers» in their houses or about their premises, for the purpose of drinking, playing, lounging or doing any secular business whatever, on penalty of 10 shillings; the persons lounging, etc., also paying not less than five shillings. On the second conviction the innkeeper is made to pay 20 shillings and on the third offense to lose his license. Loitering, walking or gathering in companies in «streets, fields, orchards, lanes, wharves,» etc., is prohibited on pain of five shillings fine; and on a second conviction the offender is required to give bail for future obedience. Absence from public service for one month is fined 10 shillings. No one is to assist at any funeral, not even to ring a bell, unless it be a licensed funeral, on penalty of 20 shillings fine. In Boston, however, a funeral might be attended after sunset without a license. The observance of the Sunday was to commence from sunset on Saturday. Twelve wardens were appointed in each town to execute these laws; these were to look after all infringements, enter all suspected places, examine or enquire after all suspected persons, etc. In Boston they were to patrol the streets every Sunday (very stormy or cold days excepted), and diligently watch and search for offenders. In case any one convicted on any point in this code failed to pay his fine at once he was to be committed to the common jail, not less than five, nor more than 10 days. These laws were to be read at the «March meeting» of the towns each year.

Practically all the States of the American Union have laws prohibitive of labor on Sunday; but these laws are practically a dead letter. In Arizona and California, however, there are no special Sunday laws. In all other States there are laws, in one form or another, providing for the Sunday-closing of saloons and general places of business, exclusive of drug stores, restaurants and businesses of prime necessity to the general comfort of the community. These laws are pretty generally observed. In some places even barber shops are closed.

Bibliography.— Baylee, 'History of the Sabbath' (1857); Cox, 'Literature of the Sabbath Question' (1865); 'Brampton Lectures' (1860); Holden, 'The Christian Sabbath' (1825); Lewis, 'Sunday Legislation' (1892); Neale, 'Feasts and Fasts'; Rule, 'The Holy Sabbath'; Schaff, 'History of the Christian Church'; Zahn, 'Geschichte des Sontags vornehmlich in der Alten Kirche.'

SUNDAY CONSTABLE. See Town and Town Meetings.

SUNDAY SCHOOLS, meetings or gatherings in which religious instruction is given to children and young people, usually orally and on Sundays. Such schools are sometimes also known as Bible classes, as the Bible is the textbook in frequent use and often the Bible and the Christian doctrine lessons are arranged in a catechetical form and hence arises the name of the textbook used, catechism, which is sometimes applied to the class or school using such a book. More commonly, however, a Bible class is one of a series of classes in a Sunday school, frequently being a class for adults and older scholars. The work of teaching religion to classes or in schools was practised in very ancient times (Gen. xiv, 14) and by the ministers of God, or their appointed assistants, whenever conditions were such that the young were not taught in their own homes (Deut. xxxi, 10–13). The study of the law was of obligation; and religious schools existed in connection with the synagogues. The catechetical method was at first in general use.

Early Christian Doctrine Schools.— The apostles, or certain persons appointed for the work, gave religious instruction to the catechumens. The religious school, among Christians, seems to have had first place; before the books of the Bible were collected as they now exist, the life of Christ had been taught orally. As Christianity extended the schools came under control of the Christians as nearly all the teachers were Christians, so the religious instruction became a part of the regular work of the school. The differences which arose at the time of Luther (q.v.) led to the establishment of classes and schools for teaching the religious beliefs of different churches. In many cases the religious teaching was continued in the schools and the new classes formed were for the poor and those, both young and old, who were not well instructed. Luther and his followers established such schools. Saint Charles Borromeo (q.v.) was one of the most zealous in founding Sunday schools in all parts of his archdiocese of Milan. He succeeded in arousing the enthusiasm and in securing the co-operation of the laity, men and women, so that he had a large number of teachers. In order to unite the workers and furnish a means of training them for the work, he established an organization called the «Confraternity of Christian Doctrine.» Besides the teachers who were members of this Confraternity, there were also others, who were called Fishers, whose duty was to gather the children and the ignorant and bring them to the places appointed, on Sundays or on week days. At the death of Saint Charles there were in his diocese alone nearly 4,000 members of the Confraternity. They taught in 740 Sunday schools and had over 40,000 pupils. Those receiving religious instruction in the regular schools were not included in this number. This Confraternity still exists. In England there is a large membership. It was introduced into the United States in 1902 and established in the archdiocese of New York by the Roman Catholic archbishop, Michael Augustine Corrigan.

Modern Sunday Schools.— Robert Raikes (q.v.) of Gloucester, England, is the founder of the modern Protestant Sunday school. He first thought of the work in connection with a number of children of wretched appearance whom he saw playing in the suburb of the city where he lived. He was informed by an inhabitant to whom he addressed himself, that on Sundays, when the children were released from work, and the few who enjoyed the benefit of any instruction during the week were free from school, they presented a more afflicting sight of misery and vice. This observation immediately suggested to him the idea that the profanation of the day might be prevented by keeping them occupied; and he engaged several women, who kept schools in the neighborhood, to receive such children as he should send to them on Sundays and instruct them in reading and the catechism, paying each of them a shilling for her day's work. He soon collected a considerable number of children, distributed books among them, gave them advice, settled their quarrels. The effects of his benevolent exertions were so beneficial that his example was followed by other charitable persons in different quarters of the city and in a few years Sunday schools were established in almost every part of Great Britain. Raikes made his first experiment in 1781 and in 1786 it was estimated that 250,000 children were receiving instruction in Sunday schools. A Sunday school society was formed in 1785 and the members were encouraged to give their personal service gratuitously. In 1803 the first Sunday school union was formed in London and the example was soon imitated in many large towns and some of the counties. The Scotch Sabbath schools (first established in Edinburgh in 1787) arose from the English Sunday schools, but from the first were more entirely devoted to religious instruction than the Sunday schools of England. The first Sunday schools united secular with religious instruction. Sunday schools were established in Protestant churches in Scotland, Ireland and America, in the years immediately following their establishment in England; the Scotch Society for «Promoting Religious Instruction Among the Poor» was formed in 1796 and the Irish Sunday School Society was founded in 1809, though a system of Sunday teaching had prevailed in Ireland for some years previously. In later times Sunday schools increased rapidly in connection with all Protestant churches throughout the world. The Sunday school movement was not at first looked upon with favor by the people of New England. It was regarded as a menace to the sacredness of the Sunday (Sabbath) and also as an infringement of the home duties. The Protestant Sunday school, as it exists to-day in the United States, may be said to have had its real beginning in Philadelphia 19 Dec. 1790, when 12 persons held a meeting and decided to begin the work. Sunday schools had been established in the United States shortly after Raikes had begun his work but they existed more as local institutions. On 11 Jan. 1791 a society was established in Philadelphia which had for its object the support of Sunday, or «First Day» schools. The president of the society was Bishop William White and Matthew Carey was the secretary. In New York 13 Jan. 1816, a woman's society for the promotion of the work and in the same place, on the 26th of February of the same year, a society of men was organized for the same purpose. The American Sunday School Union is the outgrowth of the Sunday and Adult School Union, established in Philadelphia in 1817. The new and broader organization took definite form 24 May 1824. On the 75th anniversary, the American Sunday School Union had 100,928 Sunday schools with a membership of 4,070,346 pupils and 578,680 teachers. It had distributed literature amounting to near $10,000,000. The first national convention was held in Chatham Street Chapel, New York, 3 Oct. 1832. National conventions were held 23 May 1833 and 22 Feb. 1859, in Philadelphia; 29 April 1869, Newark, N. J.; 16 April 1872, Indianapolis, Ind.; 11 May 1875, Baltimore, Md. At the Baltimore meeting the convention took upon itself the name international, to which title it had a right on account of the enlargement of the work both in aim and territory. On 1 July 1889 a world's convention was held in London. Other world's conventions have been held in Saint Louis, Mo., 3 Sept. 1893; London 11 July 1898. The organization embraces, besides the usual executive officers, lesson committees and different department workers. In many of the States are held annual State conventions, county conventions and city conventions. The department of field workers is most important. In fact their main work is the financing of missionaries in sparsely settled and neglected localities, where they found and foster evangelical but undenominational Sunday schools. Morris K. Jesup, who was for many years the president; Gen. O. O. Howard, Jay Cooke, William E. Dodge, Louis Klopsch and other prominent men have taken a great interest in the Union's work. In the decade ending 1917, they organized over 17,000 new Sunday schools, reorganized 7,000, besides aiding several thousand public schools. The Chautauqua (q.v.) has been a great aid in the enlargement of the work. In 1908 the Protestant Sunday schools in the United States, including Hawaii and Porto Rico, numbered 140,739, with a membership of 11,355,000 pupils and officers and teachers numbering 1,505,000. In 1917 the Protestant and miscellaneous Sunday schools had over 19,000,000 scholars enrolled and the Roman Catholic schools 2,850,000 more; the Methodist group was the largest, comprising 7,000,000 scholars; the Baptist group followed with 3,800,000; Presbyterian, 2,000,000; Lutheran, 1,000,000; Disciples, 940,000; Congregationalist, 750,000; and Episcopal, Reformed and United Brethren, each nearly 500,000.

All the teaching orders in the Roman Catholic Church, in all countries, give religious instruction in the regular schools, and, when necessary, classes are organized and held on Sundays. The Sunday classes are graded as are the regular school classes. The founder of the first normal school for the training of teachers, Saint John Baptist de La Salle was most earnest in having his teachers prepare themselves well for the work of teaching Christian doctrine. The members of his order (popular name, Christian Brothers) have charge of many Sunday schools. Both Protestants and Roman Catholics have established training classes and normal schools for Sunday school teachers. In New York, in 1901, under the auspices of the Confraternity of Christian Doctrine, a training school for teachers in the Roman Catholic Sunday school was established, and affiliated with it are local training classes.

Conventions and Conferences.— The Protestant Sunday School conventions, international, national, State and county, are most inspiring and educational. The question brought home to the members, most forcibly, and at all the conventions, is that the Sunday school is a necessary feeder of the Church, that to have the adult a communicant, the child must be instructed. As a direct result of the great conventions there has grown up a vast Sunday school literature, the churches have been arranged so as to provide suitable meeting places for the Sunday schools. The Sunday school hymns are also an important outgrowth of the conventions and conferences. In the Roman Catholic Church every educational convention, congress, or conference, has for its beginning and end, the subject of Christian doctrine. Sunday school conferences have been held at the Eastern and Western Roman Catholic Summer schools, and Boston and other cities have had, for some years, regular annual Sunday school conventions.

International Lessons.— In 1872 at the national Sunday school convention of the Protestant Sunday school workers, held in Indianapolis, the plan of having a series of uniform Bible lessons was proposed and met with favor. The lessons were adopted by the Sunday schools of Canada and England, and came into use in many of the Protestant English-speaking Sunday schools of the world. Several periodicals and a large number of books are published as aids for the International Sunday school lessons. Another plan of Bible lessons in use in many parts of the United States is the Blakeslee or inductive system. In the Roman Catholic churches the system in general use is based upon preparation for the sacraments (q.v.). Bible study is correlated with the catechism lessons. In addition to the general system, in many dioceses there is a prescribed course of study for the Christian doctrine work (New York, Philadelphia, Brooklyn, etc.). The Jews have regular courses of study for their Sunday schools, which in the United States are quite numerous.

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SUNDERLAND, Jabez Thomas, Amercan Unitarian clergyman: b. Yorkshire, England, 11 Feb. 1842. He was graduated from the University of Chicago in 1867 and from the Union Baptist Theological Seminary in 1870. He was editor of *The Unitarian Monthly* 1886–95, and has held Unitarian pastorates in Milwaukee, Chicago, Ann Arbor, Oakland, Cal., London, England, Toronto, Ontario, Hartford, Conn., and Poughkeepsie, N. Y. He has been director of the American Unitarian Association, secretary of the Western Unitarian Conference, president of the Michigan Unitarian Conference and non-resident lecturer on the Religions of India in the Meadville (Pa.) Theological School. He is a member of the Michigan Authors Club. Has the following honorary degrees: A.B., A.M. and B.D. from the University of Chicago and D.D. (1914) from Tufts College. He was sent to India, 1895–96, by the British and Foreign Unitarian Association, to study the educational, social and religious conditions of the Indian people, and made an extended report on the same on his return to London. In 1913–14 was Billings Lecturer of the American Unitarian Association in Japan, China, Ceylon and India. Was president of the All-India Theistic Congress, 1913. Has written extensively for magazines, reviews and other periodicals in the United States, Canada, England and India. He is author of 'A Rational Faith' (1878); 'What is the Bible' (1878); 'The Liberal Ministry' (1889); 'Home Travel in Bible Lands' (1894); 'A College Town Pulpit' (1895); 'Liberal Religion in India' (1896); 'A Pacific Coast Pulpit' (1898); 'Travel and Life in Palestine' (1900); 'James Martineau' (1905); 'The Spark in the Clod' (1906); 'Causes of Famine in India' (1906); 'The Origin and Character of the Bible' (1907); 'The Bible and Bible Country' (1909); 'Oh, to be Rich and Young' (1910); 'The Orient and Liberal Religion' (1913); 'Liberal Religion as a World Movement' (1913); 'Military Preparedness the World's Menace' (1916).

SUNDERLAND, England, a seaport town and parliamentary borough of Durham, at the mouth of the Wear, 13 miles northeast of the city of Durham and 12 miles southeast of Newcastle-upon-Tyne. The chief buildings are the magnificent Town Hall, Museum, Art Gallery, Libraries and the old parish church of Saint Peters, on the site of the monastery in which the venerable Bede was educated. Sir Joseph Swan the electrician ("Ediswan") was born here. Two lighthouses stand at the entrance of the excellent harbor. The industrial works include shipbuilding establishments, marine engine works, bottle, pottery and rope factories, coal mines, iron works, paper mills, anchor and chainworks. Coal is the chief export. The imports are timber and grain, together with materials for use in manufactures, and provisions. These are brought from Baltic ports and Holland. Pop. about 166,000.

SUNFISH, a fresh-water fish of the family *Centrarchidæ*, closely related to the perches (*Percidæ*) and including also the black bass, crappie, and calico bass. These fishes are among the most characteristic of the fresh waters of the United States, where all of the 12 genera and 30 species are found, and of these only one (*Archoplites interruptus*) occurs west of the Rocky Mountains. Because of their abundance, beautiful colors and forms, interesting habits, courage and gameness, they are perhaps the best known and most esteemed of fresh-water fishes. Most of the true sunfishes belong to the genera *Lepomis* and *Eupomotis*, and the different species are not readily defined without a long technical description; but to the layman, or rather boy, all are known collectively as "sunnies." The commonest and most generally distributed species east of the Alleghany Mountains is *E. gibbosus*, one of the brilliant beauties of our clear brooks and ponds, the type of piscine courage and pugnacity, not fearing to assault any fish that approaches its nest, and itself proof against attacks even from pickerel. Like other sunfishes, it builds a nest of cleaned pebbles on a warm sunny bottom in shallow water, and the male stands guard over the eggs until they hatch and the young are able to care for themselves. This is the boy's favorite game-fish, and it is an excellent morsel on the table. An equally beautiful and larger species, abundant in more sluggish waters throughout the same range and westward, is the blue sunfish (*L. pallidus*). The long-eared sunfish (*L. auritus*) is distinguishable at once by the long appendage of the gill cover. The spotted sunfish (*Enneacanthus gloriosus*) is a most beautiful little fish with gracefully flowing fins and brightly spotted translucent body.

A large marine sunfish is the prevailing species (*Mola mola*) of the plectognath family

Molidæ. It is almost circular in form, and the dorsal and anal fins project posteriorly, with the caudal between. The posterior part of the body looks as if it had been cut squarely off and then the tail replaced, and something like this actually happens in the development of the young. On each side, near the centre, is a small pectoral, and in front of it the gill opening; the gills are arranged in comb-like fringes. It attains a large size, four or five feet in length and three or four feet in depth, with a weight of several hundred pounds; the flesh is white, tough, of a disagreeable odor, unfit for food, and remarkably elastic, the last property depending on the great amount of yellow elastic fibre, interlaced in an intricate manner, almost to the exclusion of white fibre and muscle. It is grayish above and whitish below, with a silvery lustre when alive, and phosphorescent at night, which, with the rounded form, has given rise to a sailor's name, moonfish. It is sluggish in its motions, and is often seen asleep at the surface; when swimming, it is said to turn round like a wheel, and to be able to float with the head and eyes above the surface; the liver is very fat, and its oil is used for lubricating purposes on board ship, and for sprains and bruises among fishermen. Sailors fashion balls from the elastic subdermal tissue. In some seasons it is common in summer in Massachusetts and New York bays, and feeds partly if not principally on medusæ or jelly fishes. There is probably no fish more infested by parasites, internally and externally; the flesh and intestines contain many entozoa, and the skin is studded with crustacean parasites. Consult Gunther, 'Introduction of Fishes' (Edinburgh 1880); Bollman, 'Review of Sunfishes' (Reprint, United States Fish Commission, Washington 1892); Abbott, 'Naturalist's Rambles About Home' (New York 1887); Dean, Bashford, 'Fishes, Living and Fossil' (New York 1895).

SUNFLOWER, the common name of the New World plants belonging to the large composite genus *Helianthus*, so called because their golden-rayed heads are likened to the sun. The robust annual sunflowers (*Helianthus annuus*), native to the prairies of the American West, where they grow over large tracts, sometimes so tall that they hide a horseman riding among them, are often planted as a coarse but brilliant ornamental plant good for concealing fences and the like. The leaves are numerous, rough, very large, and somewhat heart-shaped; the flowers sometimes measure a foot in diameter, generally nodding, and inclining to the sun. The disc is very broad and brownish, and its tubular florets develop four-sided very oily achenes, which are a tid-bit for the Tartars, have been used somewhat for food by the American aborigines, and are the main resource of many western seed-eating animals and birds. In Russia, and in some modern gardens, sunflowers are grown solely for these fruits, which form a valuable food for poultry, and yield an oil, useful for either illuminating or soap-making. They are said also to be a remedy for heaves in horses. The smooth western *H. orgyalis* has narrow graceful leaves, and brown, disked flowers, and is quite apt to bloom from top to bottom, a distance of some 10 feet. *H. decapetalus* var. *multiflorus* is one of the best for cultivation, being not so coarse as other species, and having long-stemmed, clear-yellow flowers, sometimes double, and about three inches across. *H. mollis* is also interesting, for its soft, white velvety foliage, and stands only about five feet high. *H. subtuberosus*, the Indian potato, has thick lanceolate leaves, and fleshy roots, which are thick and edible. It is found on the Northwestern prairies. *H. tuberosus*, with a wider range, has ovate leaves, and fleshy thickened rootstalks bearing the tubers called Jerusalem artichokes. It often grows along roadsides in the East, having been cultivated, doubtless, by the aborigines, and is now largely grown as a fodder for livestock, especially valuable in dry seasons, and as a vegetable for fall.

SUNFLOWER STATE, a popular nickname for the State of Kansas, so named from its prolific growth of sunflowers.

SUNGA. See INDIAN HUMPED CATTLE.

SUNGARIA, soon-gä'rē-ä, or **DZUNGARIA**, a region of central Asia, once an independent kingdom. It is not well delimited but comprises generally the district of East Turkestan north of the Tarim Basin and between the Altai and the Tian-Shan mountains, west of Mongolia. In the 17th century the Sungarians extended their power over a region much greater than that above indicated. In 1670 the Chinese overran the country but were driven out after 40 years, when the Sungarians re-established their independence. The new kingdom did not last long, however, for in 1759 the Chinese conquered and annexed it to their empire. Chinese colonists were thereafter sent there in great numbers.

SUNIUM, sū'nĭ-ŭm, or **CAPE COLONNA**, Greece, a promontory forming the southernmost point of Attica, 28 miles southeast of Athens. It consists of a mountain or hill which in ancient times was fortified and crowned by a marble temple of Athene. Portions of the walls and 13 of the columns (whence the name «Colonna») of the temple still remain. At the foot of the mountain lay the silver-mining town of Sunium.

SUNKEN BELL, The. Gerhart Hauptmann's 'Versunkene Glocke' ('The Sunken Bell') (1896) is commonly supposed to be the poet's elegy on the failure of the hopes which he had set upon the attempt to adapt naturalistic methods to the treatment of an historical subject in 'Florian Geyer' (first played 4 Jan. 1896). Quite as probably, however, Hauptmann symbolized in this fairy drama a mood to which poets as such are no strangers, even without the chagrin of recent defeat: the melancholy sense that ascent to spiritual heights is toilsome and is impeded by fetters to the lower earth. Moreover, there are spirits of the depths as well as of the heights.

The bell-founder Heinrich is thwarted of his supreme ambition, to place a bell in a mountain chapel, by the malice of a wood-sprite who cannot abide the ringing of it, and despairing he plunges into the abyss which engulfs the product of his Christian devotion. His humble, unesthetic wife can give him neither comfort nor the courage to live. Both come to him from a mountain elf, Rautendelein. In association with her, he plans a new masterpiece, half church, half temple to the sun, but he is not destined to accomplish his design. The humdrum dwellers in the valley persecute him as a renegade; the wood-sprites assail him in hostility like Loki's to Balder; the tolling of his submerged bell recalls him to where his wife and children have died of grief. He repulses Rautendelein and hastens below — but only to return and discover, a moment before he breathes his last, that his proper dwelling place is with her on the heights, and that the nether sphere, the realm of failure and of death, is that from which no man can escape.

The play, rich in elements derived from German folklore, with some reminiscences of classical mythology, is enhanced by the contrast of naturalism and fantasy, and contains, along with some hollowness, the most intense and musical poetry that its gifted author has ever written. Translated by Mary Harned in 'Poet Lore' (Vol. X, 1898), by C. H. Meltzer (Garden City, 1915), and by Ludwig Lewisohn (in 'The Dramatic Works of Gerhart Hauptmann' New York 1913–15). Edited by T. S. Baker (New York 1901). Cf. Ludwig Lewisohn, 'The Modern Drama' (New York 1915).

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SUNN HEMP. See FIBRE.

SUNNAH, sŭn'ạ, **SONNA,** or **SOONNUT,** the oral teachings of Mohammed, built upon his sayings and practices, and other traditions, which are regarded as authoritative by the orthodox Mohammedans, although not part of the law, as set forth in the Koran. A great number of so-called «Traditions» were fabricated to uphold certain political and sectarian claims, but these were subsequently rejected. The six standard Sunni collections were all compiled under the Abbaside caliphs, and the earliest of them partly during the reign of Al Mamun. The four canonical collections of the Shias are of later date and less trustworthy. See also MOHAMMEDANISM; SUNNITES.

SUNNITES, sŭn'īts, or **SUNNI,** the orthodox Mohammedans, who accept as authoritative the oral teachings of Mohammed, the deliverances of the orthodox imams, and the various traditions assumed to be traceable to those who had the confidence of the prophet, in addition to the Koran, which is received as law by Mohammedans of every sect. The Sunnites regard as heretics the Shiites (Shia) who do not accept the Sunna, as the body of oral tradition is called. While the animosity between the two great divisions of Islam, like that between Christians of different creeds, has vented itself, and among the more prejudiced still finds expression, in bloodshed and bitter persecution, there is a much more tolerant feeling in the present age than existed in the past, and Shiites occupy important places in the Turkish empire, which is almost universally Sunnite. The Sunni contend that Mohammed never intended to establish any hereditary right in his descendants. See MOHAMMEDANISM.

SUNNYSIDE, Washington Irving's estate at Irvington, N. Y. It is close to the Hudson River, about half a mile north of the Irvington railway station. It was bought in 1835 by Irving, who gave it the name of Sunnyside; at that time the estate contained 10 acres, later eight more acres were added. A small stone house was standing on the estate, known as Wolfert's Roost, which during the Revolutionary War was a station of the Dutch «water guards» who watched and constantly annoyed the British ships anchored in the river. It was an old-fashioned mansion, with many gables and according to Irving «as full of angles and corners as an old cocked hat.» Its picturesqueness pleased the author's fancy, and while he had it enlarged and modernized under the direction of an artist, George Harvey, he was careful to keep its «old-time» appearance. English ivy grown from a slip brought from Melrose Abbey, was trained over the front, which it now completely covers. Though additions have been made to the house since Irving's time, the old part has not been materially changed, and maintains the same general appearance.

SUNSHINE STATE. The name given by statute to South Dakota, which is also known as the «Koyote State.»

SUNSTONE, or aventurine feldspar, a variety of feldspar showing a beautiful golden schiller. This is due to the reflection of light from the surfaces of multitudes of minute, tabular crystals of hematite or goethite, enclosed in the spar in parallel position. Under the microscope, or even with a pocket lens, these little crystals appear gorgeously iridescent. Sunstone from Tvedestrand, Norway, the finest known, is a reddish variety of oligoclase; a green microcline sunstone occurs in Pennsylvania.

SUNSTROKE, prostration due to exposure to intense external heat. Such exposure may be to the direct or indirect rays of a tropical sun or to the excessive heat of an engine room. In either case heat and physical exertion combine to bring about the results. A high degree of humidity of the atmosphere is one of the most important features, since this hinders free evaporation of fluid from the body which is one of the most important devices for cooling the body. Sunstroke is an old disease. Osler mentions that two instances are on record in the Bible and many of the ancients described it very well, confounding the severer forms with apoplexy. Two main types are seen — heat exhaustion and heat stroke. Other terms for heat stroke are isolation, thermic fever, coup de soleil.

Heat exhaustion is frequently seen among workmen who are exposed to the direct action of the sun. Bricklayers, drivers, farmers, etc., or firemen and stokers in large vessels, while in the midst of their work suffer from extreme prostration. There is great restlessness, muscular weakness, fainting spells and collapse, and often delirium. The surface of the body is usually cool and the temperature may be subnormal, 95° to 96° F., the pulse is small and rapid and unconsciousness rapidly develops. In heat stroke or thermic fever, the symptoms are quite different. Here marked physical exertion and direct exposure to the sun with high humidity are important factors — in addition some form of alcoholic drink is being taken, notably ale, beer or whisky. In the severe grades the patient may be suddenly struck down and die with rapid breathing, heart weakness and unconsciousness. These cases are rare and frequently, on autopsy, turn out to be something else. The more common type commences with severe headache, dizziness, a sense of weight in the head, and nausea and vomiting. If these signs are disregarded and the patient continues to march, if a soldier; or to stoke, if a stoker; or to work, if a laborer, symptoms of disordered vision develop; diarrhea and increased urination are present and then unconsciousness sets in. Seen in this condition the patient is usually flushed, the eyes blood-shot, the skin is hot and dry, the temperature, an important sign, is very high, 105° to 110° F., or in some cases even higher. The pulse is rapid and bounding; the breathing is apt to be noisy, and the patient, apart from his very high temperature and dry skin, may seem to be suffering from alcoholism. The pupils may be dilated or contracted and there may be an eruption on the skin. In these cases that end fatally the unconsciousness deepens, the temperature mounts, convulsions and twitching occur, the breathing becomes very irregular and shallow. A gradual fall in temperature and a return to consciousness are symptoms of recovery. Many patients after recovery have a permanent susceptibility to high temperatures.

It is important to distinguish between these two forms of heat poisoning as the treatment is radically different. In heat exhaustion there is vasomotor paralysis with cold wet skin and subnormal temperature, and patients should receive alcohol hot bottles and supportive treatment. Heat stroke should be treated by cold and stimulants. The body should be drenched with cold water. The wrists and sides of the neck rubbed with icewater or ice, as the large arteries are here more readily reached and the blood more rapidly cooled. Icewater rectal injections are also useful to reduce the temperature rapidly and also to empty the bowels, an important indication. It may be necessary to immerse the patient directly into an ice bath. During this treatment careful readings of the clinical thermometer must be taken and as soon as the temperature sinks below 102° to 103° F., and stays there, the cold applications may be discontinued. Moderate venesection is not contraindicated, but that is a technical question for the physician to decide. In malarial countries, particularly below Mason and Dixon's line, quinine may be used to advantage to obviate possible malarial combinations. Coal tar antipyretics are not advisable if signs of heart weakness are present. Of cardiac stimulants ammonia is the most serviceable, as it can be breathed by an unconscious patient. Sometimes chloroform is essential to control convulsions.

The mortality from heat exhaustion is about 9 per cent, whereas the high mortality of 25 per cent is recorded for heat stroke or thermic fever. Consult Manson, 'Tropical Diseases' (1900); 'Sunstroke' in 'Encyclopedia Medica' (1902); Wood, 'Thermic Fever, or Sunstroke' (1872).

Smith Ely Jelliffe, M.D.

SUPEREROGATION, performance of more than duty requires, for example, if one commits theft of a dollar and makes reparation of the wrong by giving back two dollars; or if one not only forgives those who injure him, but confers unmerited benefits upon them. The Anglican Church, in the 14th of the 39 Articles of Religion, expressly condemns the notion of works of supererogation as impious: «Voluntary works besides, over and above, God's Commandments, which they call Works of Supererogation, cannot be taught without arrogancy and impiety; for by them men do declare that they not only render unto God as much as they are bound to do, but that they do more for his sake than of bounden duty is required; whereas Christ saith plainly, When ye have done all that are commanded to you, say, We are unprofitable servants.» Supererogation is not a term of theology in the Roman Catholic Church; but that Church teaches that good works done by the faithful in the state of grace are meritorious of eternal reward, and that merits of holy men redound, through the goodness of God, to the spiritual advantage of the whole Church. This doctrine differs not from that taught in the 'Institution of a Christian Man,' published by authority of convocation in 1537:

> "I believe that whatsoever spiritual gift or treasure is given by God unto any one part or member of this mystical body of Christ, although the same be given particularly unto this member, and not unto another, yet the fruit and merit thereof shall, by reason of that incomprehensible union and bond of charity which is between them, redound necessarily unto the profit, edifying, and increase in Christ's Body of all other members particularly."

SUPERFŒTATION, a second conception and the formation of a fœtus after a previous impregnation in the same female, whereby two fœtuses coexist in the uterus. In such a case a woman may be delivered of a full-grown child and of an undeveloped embryo at the same time, the period of conception of each being presumed to be different; or a woman may be delivered of two living children, the one appearing much more developed than the other. In recorded cases women have given birth to twins, the one child being white and the other black, showing that each had a separate father and of a distinct race, and proving the possibility of a double conception. But far more typical cases of superfœtation have been found. Such is that instance in which, as published by Eisenman of Strassburg, a woman was delivered of a second child 140 days after the first, both children being fully developed. In this case, therefore, the second child must have been conceived at a later and different period from the first; and the development of the second child must have been proceeding separately from that of the first, and after the latter was born. Still more remarkable cases of this kind have been recorded. The explanation of these curious cases has afforded a very intricate study and puzzle to obstetricians and physiologists, as well as to those concerned with their medico-legal aspect, which sometimes bears directly upon questions of conjugal fidelity. As the subject at present stands, its full elucidation is still a matter for obstetrical investigation; but there can be little doubt either of the actual occurrence of cases of superfœtation, or of the great importance of the study of its phenomena.

SUPERHEATERS. See Locomotive.

SUPERIMPOSED DRAINAGE. When a stream flowing across a region cuts down and uncovers an old buried erosion surface the drainage is said to be superimposed on that surface. For example, if any familiar region of hills and valleys should sink beneath the sea, and all the old surface be buried beneath sands and muds, a plain would result. If this plain would then emerge and rivers were to start flowing over it, the new streams would pay no attention to the old buried topography, but would wander freely over the plain. As they cut down the region, they would uncover this old topography, and would then be superimposed. Such is much of the drainage in the glaciated regions, where glaciation has filled up the old valleys, and obliterated the old preglacial drainage.

SUPERIOR, Wis., city, port of entry, county-seat of Douglas County, on Lake Superior, and on the Northern Pacific, the Chicago, Saint Paul, Minneapolis and Omaha, the Duluth, South Shore and Atlantic, the Great Northern, the Minneapolis, Saint Paul, and Sault Sainte Marie, the Chicago, Milwaukee and Saint Paul and the Chicago and Northwestern railroads opposite Duluth. It shares with Duluth the commercial advantage of being the extreme western port of the Great Lake system of the United States. It has three connecting harbors, well sheltered and deep, making a combined length of 13 miles, with an extreme width of three miles. The city comprises the ports known as East, West, South and Old Superior. The climate is cool in summer and cold in winter. The chief manufacturing establishments are flour and lumber mills, iron and steel works, boiler works, windmill, factories, shipyards, bag factories, tractor factories, cooperage, chair factory, wagon and carriage works. Lath, shingles and other lumber products are also manufactured. It has also shipyards, coal docks capable of receiving 6,370,000 tons of coal, large grain elevators, a large dry-dock and a number of wholesale merchandise establishments. The government census gives the amount of capital invested in industries $7,050,000 and the annual value of the products $11,663,000. There is an extensive lake trade, and railroads furnish transportation for products sent to the interior. The principal public buildings are the government building, county courthouse, municipal buildings, Saint Francis Hospital, Saint Mary's Hospital, Women's Christian Temperance Union Hospital, national and State banks, several business blocks and hotels. The educational institutions are a State normal school, the Finnish University, two business colleges, two high schools, public and parish schools and two public libraries. The commission form of government is in operation. The port's foreign trade has become extensive in recent years, having now an annual volume of about $1,500,000, of which 80 per cent is in exports. The city's annual expenditure on various municipal activities is about $550,000, of which $200,000 is expended on schools, $100,000 on fire protection and $60,000 for police. Pop. about 62,500.

SUPERIOR, Lake, the largest expanse of fresh water in the world and the most westerly and most elevated of the great lakes of the Saint Lawrence basin; lat. 46° 30′ to 49° N.; long. 84° 30′ to 92° 20′ W. It washes the shores of the State of Minnesota on the west, of Wisconsin and the northern peninsula of Michigan on the south and of Canada on the north and east. The greatest length, measured on a curve through its centre from east to west, is 420 miles; greatest breadth, 167 miles; circuit, about 1,750 miles; estimated area, 31,200 square miles; height above sea-level, 602 feet; approximate mean depth, 900 feet; maximum depth, 1,008 feet. It is of very irregular shape, widening out toward its centre and gradually narrowing, partly toward its eastern but much more toward its western extremity, so as to form an irregular crescent, with its convexity on the north and its concavity on the south. The northern shore is generally bold and elevated, presenting almost continuous ranges of cliffs, which vary in height from 300 to 1,500 feet; the southern shore is low and sandy, though occasionally interrupted by limestone ridges, the most remarkable of which, situated toward the eastern extremity, present a perpendicular wall 300 feet high, broken by numerous caverns and projections, and forming, under the name of the Pictured Rocks (q.v.), one of the greatest natural curiosities of the United States. The central portion of the lake is clear of islands, but these are numerous toward both the southern and the northern shores. In the former direction they are small, and, being insufficient to give shelter behind them, only increase the difficulties of navigation without contributing to form a single good harbor. On the north shore several of them, more especially the Isle Royale, are of considerable dimensions, and along with the indentations of the coast afford good shelter for vessels. The water of the lake, remarkable for its transparency, derives its supplies from a basin which is estimated at 54,000 square miles, and is drained by more than 200 streams. The water never freezes except in the shallow regions along shore. About 30 of the islands are of considerable size, but they are almost all impetuous torrents, interrupted by rocks and rapids. Superior discharges into Lake Huron, at the southeast end, by Saint Mary's River, which at Sault Sainte Marie descends 22 feet in three quarters of a mile, navigation being here carried on by means of two ship canals, one on the Canadian, the other on the United States side. Within the lake itself the only obstruction to its navigation are the violent gales to which it is subject. It is well supplied with fish, principally trout, whitefish and sturgeon. There are a great number of fishing-stations. Large deposits of copper and iron are worked on the shores of the lake, especially on the southern shore along the northern coast of Michigan. The boundary line between Canada and the United States, in passing through Lake Superior, proceeds from the outlet nearly through its centre till it approaches Isle Royale, when it bends north so as to give that island entirely to the United States, and is then carried south-southwest to its termination at the mouth of the Pigeon, in lat. 48° N. The chief towns on the shores of Lake Superior are Duluth, Minn., at the western extremity, with an excellent harbor; Superior, Wis., near Duluth; Marquette, Mich.; Fort William, Ontario, also with a good harbor; and Port Arthur, Ontario. Consult Agassiz, 'Lake Superior: Its Physical Character, Vegetation and Animals' (Boston 1850) and Martin, 'Progressive Development of Resources in the Lake

Superior Region› (In American Geographical Society publications, Vol. XLIII, New York 1911).

SUPERNATURALISM, «above nature» or miraculous, in theology, the generally received belief that divine revelation is the sole and ultimate ground of the Christian religion; it is opposed to naturalism, the theory that while the Scriptures contain many truths these truths are only a reassertion of natural religion and therefore unnecessary; it is also opposed to rationalism (q.v.), which makes reason the supreme arbiter in all matters connected with revelation and the religion of Christ. Supernaturalism regards the Christian religion as an extraordinary phenomenon out of the circle of natural events and as communicating truths above the comprehension of human reason. Though the supernaturalist, no less than the rationalist, employs reason in matters of revelation, he does so only to search and judge those claims to a divine origin which Christianity puts forth; when he is once convinced that Christianity contains the direct teachings of God, it becomes his highest, his sole authority; called also supranaturalism.

SUPERPHOSPHATE FERTILIZERS. See Fertilizers.

SUPERSTITION, Popular. That which others believe and we do not, is classed as superstition. The religion of our friend, if differing radically from our own, seems to us a superstition. In the heart of nearly every human being, savage or civilized, exists a settled conviction that he dwells in the midst of an unseen world, peopled with beings of strange powers, who thwart the plans of his own life or assist him in his endeavors. Folklore, legends, ghost stories and witch tales were early in the 19th century regarded as mere fables, but in the light of modern science they are now as worthy of study as the surely not less indelicate recitals of Roman and Greek mythology. Every profession, trade and occupation has its peculiar superstitious lore. Even the farmer who sudies the actions of animals will tell you what they portend concerning the weather and in many cases sensibly, too, for they build their homes and lay in their food through instinct given by Divine Providence with reference to the coming winter; they house themselves before the coming storm; their coats are heavy or light, as the winter shall be severe or otherwise, and they often give the farmer who watches them valuable indications concerning his crops. So to a greater or less extent man has followed the habit of the bird and the beast; he has been guided in all his acts by omens; he has often planted his crops, gathered his harvests, made his journeys, waged war, built his house and gone fishing and hunting according to imaginary signs and superstitious beliefs. Though many of the old omens and superstitions have passed into oblivion, there still remain among every race of people hundreds and thousands of popular beliefs and many of them seem destined to be extant as long as man exists. As indicative of the variety, peculiarity and unusual extent of present-day superstition, the following examples selected from the folklore of the different nations and peoples of the world and now first collected will prove of undoubted interest alike to scientist, student and casual reader.

Superstitions of the World.

Africa.— The snake is held in superstitious reverence by some African natives, who once a year kill a cobra de capello and hang its skin to the branch of a tree, tail downward. Then all the children born during the last year are brought out and made to touch the skin. This, their parents think, puts them under the serpent's protection. The Kaffirs use the venom of the puff adder, to poison their arrows, and when they have any small quantity left they swallow it, having a theory that it will protect them from the effects of future bites. If they find a dead serpent they dress it in clothes and give it a superb funeral.

American Indian.— Various tribes of American Indians have a theory that every white deer has a «mad stone» in his stomach. They believe that the «Great Spirit» places this stone in the white deer's stomach to absorb poisons which that delicate animal may take in while eating grass. Feathers figure very prominently in the religious customs of most aborigines, and remarkably so in the Southwest. Among Navajos and Pueblos alike these plume symbols are of the utmost efficacy for good or bad. They are part of almost every ceremonial of the infinite superstitions of these tribes. Any white or bright-hued plume is of good omen — « good medicine,» as the Indian would put it. The gay feathers of the parrot are particularly valuable. The Navajo Indian will not eat fish under any circumstances, and cherishes the belief that the use of such food will be followed by dreadful punishment.

Arabia.— Many Arabs, when overtaken by severe storms in the desert, cry out, «Iron! Iron!» which they think will propitiate the evil spirits who have raised the storm.

Arctic Regions.— The Eskimos believe in ghosts. Many also believe in the transmigration of the souls, that spirits return in animals, winds, rocks, ice and water, that they are evil, angry or good, as the elements may be favorable or unfavorable, and that they can be appeased by hoodoo rites if the performer is sufficiently versed in occult sciences. To change the wind they chant, drum and howl against it, build fires, shoot against it, and, as a last resort, fire the graves of the dead. Eclipses of the moon create the greatest consternation and almost paralyze the people with fear. When a child dies in some parts of Greenland, the natives bury a live dog with it, the dog to be used by the child as a guide to the other world. When questioned in regard to this peculiar superstition, they will only answer, «A dog can find his way anywhere.»

Australia.— Some Australians say that Mityau, the moon, was a native cat, who fell in love with some one else's wife, and was driven away, to wander ever since. The natives of New Zealand tie the hands of their dead together and pull out their nails; this is for fear that the corpse may scratch its way out of the grave and become a vampire.

Bohemia.— The peasants of Bohemia have a queer superstition by which they think to rid themselves of the depredations of sparrows among their crops. A frequent charm is to plant, in the centre of the field, a stick or splinter of wood taken from the timber of which a coffin has been made, or to scatter about pieces of the coffin itself. It is also considered very effective to lay upon the threshold or window-sill of the barn or storehouse a human bone taken from a grave. In Bohemia the willow is said to be the tree on which Judas hanged himself, and it is supposed to have a special attraction for suicides.

Brazil.— Religious superstitions are common here. Once a year some churchmen dress up a figure to represent Judas (usually with red hair and sandy beard), and give it to the street arabs, who carry it about until it has been riddled by stones and other missiles and then burn it on the commons. In the same country the sailors dress a figure on certain feast days, subject it to all sorts of indignities, winding up the ceremony by hanging it at the yard-arm.

China.— Many Chinese guard their homes from witchcraft by suspending bunches of herbs and magic plants over the door. At the new year the Cantonese clean out their houses and post near the doors a pair of scrolls made of red paper (the lucky color) bearing an inscription such as «Leaves of the moxa, like a banner, procure a hundred blessings.» In China the peony is regarded with superstitious reverence and pride. In China, too, the old man of the moon is known as Yue-loa, and holds in his hands the reins of marriages among mortals. The future husband and wife are tied together by an invisible silken cord, which is only severed at death.

Cuba.—A belief very prevalent among the common people is that the rain water of May has peculiar beneficial qualities which that of no other time possesses. The moonlight in Cuba seems particularly objectionable, and strangers are warned not to go out in it with uncovered head, and not to go out in it at all if it can be avoided; it is thought that this light brings many evil effects and not under any circumstances will a superstitious Cuban sleep in its rays — he thinks that, among other things, it will draw his mouth to one side of his face. The hooting of an owl is taken as a very bad sign. The superstitious Cuban kills any creature of this kind which makes weird sounds near his home. This is supposed to break the spell, and it is not then inevitable that a member of the family shall meet death in the near future.

Egypt.— When Egypt was in the height of her power her people worshipped a black bull with a circular white spot in the exact centre of his forehead, and the advent of such a creature in any herd was the signal of wild demonstrations. Even as late as the time of Cleopatra such animals were shod with gold and had their horns tipped with the same metal. Herodotus tells of a man who died with grief because he sold a cow that soon after became the mother of a black bull calf marked with the sacred white circle in his forehead. In modern times the Egyptian housewives mark their bread loaves with a cross, and housemaids insure a brisk kindling of a newly lit fire by making the same sacred sign over the grate. The sacred ibis of the Egyptians was supposed, from the color of its feathers, to symbolize the light and shade of the moon. It is said that its feathers would scare, and even kill, the crocodile. The bird was believed to deliver Egypt from winged and other serpents that came from Arabia. It was so deeply venerated that it entered the most sacred temples with impunity, and to kill one, even by accident, was a crime punishable with death. After death, its body was embalmed, and thousands of their remains have been found at Thebes, at Memphis and at other Egyptian cities.

England.— In England there existed, even so late as the 18th century, a superstitious belief that a man condemned to be hanged could escape that undesirable fate provided some compassionate woman came forward at the foot of the gallows and expressed her willingness to marry him. Superstition has always clung to the cricket. In Hull it is unlucky to kill them, and in Lancashire, it is said, they cut holes in the worsted stockings of those members of a family that kill them. It is a custom in many parts of England and the Continent to announce to the bees a death in the family, especially that of the master. It is said that if a swarm of bees settle on the dead branch of a live tree a death will occur in the family within a year. In some places it is thought unlucky to sell them. They are given away for another gift. It was a popular superstition in Norfolk that whatever you are doing the first time you hear the cuckoo, that you will do most frequently all the year. The English housewife will not sweep the dirt out of the front door, fearing to sweep away the fortune of the house. In the north of England, the peasantry do not favor naming a child after some respected ancestor; that departed worthy might not like it. In the same locality when the dairy maid churned for a long time without making butter, she would stir the cream with a twig of mountain ash and beat the cow with another, thus breaking the witch's spell. But to prevent accidents of this nature it has long been customary to make the churn staff of ash. For the same reason herd boys employ an ash twig for driving cattle. In England it was thought, and not many years ago, that oak trees were mysteriously protected, and many superstitions clung round the sacred tree. The hawthorn used to be hung up at the entrances of houses in May to guard the dwelling from witches. In Devonshire it was considered unlucky to plant a bed of lilies of the valley, as the person who did so would surely die in the course of the next 12 months.

Fiji Islands.— In the mountain country of the Fijis there is prevalent a superstition called by the natives «Tuka.» The priests profess to possess an elixir of life, which, preventing decay or disease, insures to faithful disciples of this faith everlasting youth and vigor and a robust enjoyment of life. The natives who give their adherence to these priests (and this means the giving up of all they possess to them) are promised the life of immortal youth, the immediate resurrection of their ancestors, vengeance on all their enemies and oppressors, whose wives and property they should inherit, together with all the wealth of the white settlers, these latter being also promised to them for domestic slaves.

France.— Perhaps the most common of all French spread superstitions is the belief met with through all the south of France, that the position of a drowned body may be discovered by a floating loaf of bread. Possibly the only scientific basis is that the loaf is apt to be carried by a current of water just as a body is. The French peasant's faith in fermented grape juice is truly beautiful. If his children are stricken with the measles he gives them beakers of wine, well sweetened with honey and highly spiced with pepper. For a severe cold he administers a quart of red wine and a melted tallow candle mixed. For scarlet or brain fever he gives eggs, white wine and soot, well beaten together. Not all their superstitions are curious — some are pathetic. A mother, for instance, often buries her dead child with its favorite toy, or her own beautiful hair in the coffin, «that it may not feel quite alone.» Along the sea coast, unless the waters are strewn with flowers by the fishermen's wives and daughters, there will be no fish to catch. A curious superstition which is current among the street gamins of Paris and the large cities of France, is that which makes it unlucky to pass a priest. To break the ill luck, the passer must immediately touch a piece of iron. Gamins carry in their pockets pieces of iron to touch, but none of them seem to know the wherefore.

Germany.— Throughout northern Germany and in the Low Countries the stork is held in beloved reverence, for the peasants believe that where the stork has its brood no fire can ever come. There is a German belief that any one who during his lifetime may have made cats his enemies, is certain to be accompanied to the grave amidst a storm of wind and rain. It is said to indicate good luck to have a spider spring his web downward toward you, but bad luck when he rises toward you. If one has a four-leaved clover, and carries it about on Christmas eve it is believed the owner has the power to see witches. In Germany the apple has been deemed potent against warts. In Pomerania it is eaten on Easter morning as a preventive of fever. «If on Christmas night,» says a German proverb, «the wine ferments heavily in the barrels a good wine year is to follow.»

Greece.— Before a Greek selects the day for his wedding he observes most minutely every omen, and with prayer and fasting and sacrifice, takes every precaution. The Grecian mother, before putting her child in its cradle, turns three times around before the fire while singing her favorite song, to ward off evil spirits.

Hawaii.— In the Hawaiian Islands the superstition that the Kanaka holds dearest is that concerning the power of the Kahuna, or native witch doctor. This power is almost limitless. If a native in any way offends a Kahuna he is in deadly fear that he will be condemned to die, and he immediately hunts up a Kahuna higher in rank than the one whom he has offended and asks to have the curse offset and neutralized.

Iceland.— The Icelanders have a superstition which they call «Skipamal,» or the speaking ship. They conceive that utterances came forth from the motionless hulls of vessels; but few can understand the strange language.

India.— The natives of India have many curious beliefs and superstitions, some of which are essentially Oriental in their nature. The Hindus think it brings a person ill luck to be openly admired or praised, and if you should praise or even look too admiringly at a child the mother will hastily withdraw it from notice, and either beat it or say something disparaging of it in order to counteract your ill-omened admiration and avert the jealousies of the gods. In Burma it is rather a suspicious thing to give money for a charitable object. It is supposed to mean that the donor has been very wicked and is desirous to make amends. The Hindu troubled with a wart looks at the new moon, picks up a pinch of dust from beneath his left foot, rubs the wart with it — and when the moon goes so does the wart. In India one may observe the quasi sign of the cross which a Hindu makes should he chance to sneeze while performing his morning ablutions in the Ganges. Having touched his forehead, nose, chin and cheeks with the tip of his finger, he recommences his prayers from the very beginning, and will do so as often as they are interrupted.

Ireland.— The Irish peasant is subject at all seasons to the sense of shadowy supernatural agencies. But at no other time is his helplessness against such fateful and inexorable agencies brought home to him as in Lent. Moreover at this time the auguries and omens assume an especially depressing complexion. Thus the «keen» of the Banshee, always an eerie presager of death, when it occurs during Lent has the gloomy significance of a double funeral. Peasant mothers in Ireland still carry their children to holy wells where the little ones are made to creep on hands and knees beating their infant breasts the while they pray and plead for Lenten mercy on their own and the manifold sins and wickedness of their fellows, and are bathed in the blessed water which is credited with a miraculous power of averting sickness and washing away sin. The ceremony is completed by tying to a tree in the neighborhood of these consecrated springs, shreds of colored rag as a thank-offering and propitiation to the particular patron saint who is believed to preside over the birth of the child and to hold its future in his keeping. The people in the south of Ireland are particularly fearful of the robin entering their houses, for they say that it is always a certain prognostic of severe snows and frosts.

Isle of Man.— One of the superstitious customs in Manxland is for the family on stormy nights to retire to rest at a very early hour, so that the good fairies may unobserved enter to find shelter and repose.

Italy.— In Italy the snake is invulnerable except during the full vintage of the moon, when the serpents are believed to become drunken on the vineyards, and may be slain. The slaying of one of these serpents, though, would be the calling down on the head of the slayer and his family forever some terrible plague. The superstition about snakes as guardians of buried treasure seems to be a favorite one with the Italian peasantry; for they believe that all snakes hover about where such treasures are. In Sicily the time honored superstition of the «Evil Eye» is still so widely spread throughout the island, even among the upper classes, that no one who does not wear a charm is considered safe. A Venetian superstition is that the young girl across whose feet dirt is swept will never get married. The periwinkle has in Italy gained for itself the name of Death's flower, from the ancient custom of raising it for garlands when an infant died.

Japan.— Japanese sailors think it is a good omen to cross the bows of a foreign vessel and frequently they run into considerable danger in order to do it. The Japanese have some curious ideas about their finger nails. One of them is to the effect that they must not be cut before starting on a journey, lest disgrace befall the person before he reaches his destination. Neither should they be cut at night, lest cat's claws should grow out. To throw nail parings into the fire is to invite some great calamity. If, while trimming the nails, a piece should fall into the fire, the person will soon die. They are superstitious about many flowers and will have none of them. Many favorites, as the orchid, gentian, daphne and azalia are utterly prohibited for felicitous occasions. There is also with them an aristocracy of flowers most sharply defined. The iris is of princely dignity, but because of its purple color must not be used for weddings. Some flowers in themselves are regarded as being of ill omen. Such is the camelia, for instance, which is neglected because its red blossoms fall off whole in a manner which reminds them of decapitated heads.

Java.— When search is made for the body of a drowned person a live sheep is thrown into the water and is supposed to indicate the position of the body by sinking near it.

Mexico.— In Mexico the Indian carnation bears the name of the flower of the dead, and when a virgin dies it is customary for a young woman to carry a garland of flowers and sweet herbs in front of the coffin. The high priest of the ancient Mexicans gave aloe leaves, traced over with sacred characters, to people going among volcanoes, to protect them from the incident dangers.

Norway.— Norwegian sailors believe in the existence of a heck or merman, a sea animal represented as having a fish body with the head of a man and the flowing ringlets of a boy. The merman sits upon the waves, plays the harp and, following the example of many of the Norse fishermen, wears a red cap. It is never seen more than once in seven years, and no matter how many vessels appear in its sight they all must inevitably perish. A curious custom is practised in Norway, where those in search of a drowned body row to and fro with a cock in the boat, fully expecting that the bird will crow when the boat reaches the spot where the corpse lies.

Persia.— In Persia the crowing of a cock is the sign of some event affecting the family, and the master of the house hastens to feel the bird's feet. If they are cold it is a premonition of death; but if they are warm the sign is propitious, and the master rejoices in coming good fortune.

Peru.— To procure rain the Peruvians used to set a black sheep in a field, pour chica over it and give it nothing to eat till rain fell.

Philippine Islands.— In the interior mountain districts the natives have gods innumerable; gods of the air, of the water, and in fact of everything imaginable. When sickness or death approaches, the witch or sorceress of the village is called in. An ox and a pig are killed; she places the reeking skull of the pig over her own head and works herself into a frenzy of invocation. The spirits of the dead receive special honors and sacrifices are made in their behalf. Many curious demons and hobgoblins abound in Philippine superstition, too numerous to be described in detail.

Poland.— Poland has a wealth of animal superstitions. The goat is there considered the best harbinger of luck, while the wolf, crow and pigeon are looked upon as unlucky. The skin of a cat worn on the chest is alleged to cure consumption.

Romany.— The people of the gypsy tribe believe that a coin or shell or pebble carried by a person becomes imbued with his or her personality. For that reason the Maria Theresa dollar is sought after by Romany people throughout the world. In all lands this piece of money is held in high esteem for magical purposes. The gypsies believe that witches use egg shells to make plates, pots and dishes to feed from at their banquets.

Rumania.— Rumanian mothers tie red ribbons around the ankles of their children to preserve them from being harmed.

Russia.— Superstition has always found a place in Russia. The Russian General Skobeleff would never ride in battle any other horse than a gray one, since it was on a gray horse that he fought his first battle (in the Russian war, 1863) and he believed that it would be fatal to him to change afterward. The primitive Russians place a certificate of character in a dead person's hands, which is to be given to Saint Peter at the gates of heaven.

Samoa.— The natives of Samoa, in order to secure the admission of a departed spirit to the joys of their paradise, wreathe the head of the corpse with flowers, and offer, as the Chinese do, a baked pig to their god in the name of the departed.

Scotland.— In Scotland it is considered unlucky for the mother and her baby to go out of doors until the child is baptized; to be engaged with a ring containing either opals or emeralds; for lovers to give either a Bible as a present before marriage; to be married in a month where there is a letter *o*, such as May; also unlucky for any of the wedding guests to be dressed in green or black; a crepe bonnet or a band on a gentleman's hat. These ill omens entail lifelong misery to the newly married couple. A young woman who tries on a widow's cap is sure to be a widow after marriage. It is unlucky to try on your bridal dress before the bridal day; to see your future husband on the day of the marriage until the ceremony. To bring flowering hawthorn into a house denotes a death in the family. In Scotland all salt cellars should be full on New Year's Day; otherwise the household having the empty cellars will suffer want during the ensuing year. In Scotland to pass a barefooted woman before going on board ship will result in scaring the fish away, and men bearing the names Rosse, Fullie and White must never be on a fishing boat at the same time for the combination will «hoodoo» the catch. Scotch sailors will not speak of a four-footed animal while on the ocean.

Solomon Islands.— The savages of these islands believe that the world is a cocoanut shell of enormous dimensions, at the top of which is a single aperture communicating with the upper air, where human beings dwell. At the very bottom of this imaginary shell is a stem gradually tapering to a point which represents the beginning of all things. This point is a spirit or demon without human form, whose name is «Root of All Existence.» By him the entire fabric of creation is sustained. In the interior of the cocoanut shell, at its very bottom, lives a female demon. So narrow is the space into which she is crowded that she is obliged to sit forever with knee and chin touching. Her name is «The Very Beginning,» and from her are sprung numerous spirits. They inhabit five different floors, into which the great cocoanut is divided. From certain of these spirits mankind is descended. The islanders, regarding themselves as the only real men and women, were formerly accustomed to regard strangers as evil spirits in the guise of humanity, whom they killed when they could, offering them as sacrifices.

Spain.— The Spaniards never put the left foot down first when stepping on board a vessel, for to do this will surely bring disaster. Spaniards, in the 16th century, believed that spiders indicated gold where they were found in abundance. In Spain the new born infant's face is swept with a pine bough to bring good luck.

Sweden.— In Sweden it is unlucky to kill a stork, a robin or a swallow. If one kills a wren he will break a bone before the year is out. It is also unlucky to kill a marten. Many animals possess the power of curing diseases. Three hairs taken from the «cross» of an ass, that is the mark running up the back and out at right angles over the shoulders, will cure whooping-cough, but the ass will die. Another sure cure for whooping-cough can be obtained by asking and following the advice of a man riding a piebald horse. Swedish sailors will not mention the name of the port for which they are bound.

Switzerland.— If a huntsman, on going out in the morning, sees a fox cross his path, or meets an old woman or friar, he immediately returns home again; as he is persuaded that, in the first instance, he will meet with no game, and in the other that he will shoot a man hidden in the leaves, or do some other irreparable mischief. In the Alps the mountaineers believe that if the cuccoo sings in the direction of the north, it will rain the next day; but if toward the south, the weather will be fine. In the Tyrol if a youngster look pale and sickly his parents suspect that the moon-rays must have found their way into his bedchamber.

Turkey.— In Turkey if a cat enters a chamber where a person is dying and manages to pass over his or her body before being driven from the room, both the dying person and the cat become vampires and live ever after by sucking the blood from living people. If one finds a piece of bread lying upon the ground he must pick it up, kiss it and carry it until he finds a hole into which it can be inserted. To step upon a piece of bread or to leave it lying upon the ground is one of the unpardonable sins and dooms the offender to the third hell, where he is perpetually gored by an ox that has but a single horn, and that in the centre of his forehead. The Turk is convinced that misfortune hovers nigh when he sees a rose leaf fall to the ground, and many people pay particular attention to the flowers and leaves which are decaying, gathering them carefully to prevent them from dropping.

United States.— In Michigan a double cedar knot is carried in the pocket by some to cure rheumatism, and in New Hampshire a man may carry a gall from the stems of goldenrod for the same disease. Hickory nuts, the buckeye and its cousin, the horse chestnut, which brings good luck in New Jersey, are other foes to rheumatism in different localities. Some people wear a strange ring made of a potato with a hole bored through it for rheumatism and others carry a plain potato in the pocket. The charm is more potent if the potato has been stolen. According to a Maine belief, a nutmeg pierced and hung on a string around the neck prevents boils, croup and neuralgia. In some parts of Massachusetts the cows are believed to forecast the future, and if they «moo» after midnight it is a warning of an approaching death in the family. Among the West Virginia mountaineers the crowing of the cock before the door tells of coming company. It is believed on Cape Cod and in many other districts along the New England coast that a sick man cannot die until the ebb tide begins to run. In New England the sailors carry as a talisman a bone taken from a living turtle, a pebble from a fishhawk's nest or a small bone from the head of a cod. In Connecticut the belief holds that beans and potatoes must be planted in the old of the moon to prevent them running to vines. In Texas some superstitious people carry a small bone from a fish's head, but the luck only comes after the charm has been lost. See also AMULETS; AMERICAN MYTHOLOGY; DIVINATION; FOLKLORE; GREEK MYTHOLOGY; LEGEND; MASCOTS AND HOODOOS; MEXICO — MYTHOLOGY; MYTHOLOGY; OMEN; TALISMAN; WITCHCRAFT, etc.

SUPPÉ, soop-pā, **Franz von,** Austrian opera composer: b. Spalato, Dalmatia, 18 April 1820; d. Vienna, 21 May 1895. His musical ability early manifested itself and when he was but 15 years old he composed a mass which was sung at the Franciscan church at Zara. His first opera, 'Sommernachtstraum,' appeared in 1844. His best known works are the operas 'Fatinitza' and 'Boccaccio,' and his overtures 'Poet and Peasant' and 'Morning, Noon and Night.' He was for many years Kapellmeister at Vienna.

SUPPLE-JACK, the popular name given to various strong twining shrubs, for example, certain West Indian species of *Paullinia* and *Serjania* which furnish walking-sticks; or *Cardiospermum grandiflorum* or the high-climbing shrubby *Berchemia scandens*. This last is found in the southeastern United States and has tough, terete branches, oval leaves, small greenish flowers in panicles and oval purple drupes, which render it conspicuous in autumn. The supple-jacks of Australia are climbing, woody varieties of *Clematis aristata*, and that of New Zealand is one of the largest brambles known (*Rubus australis*), reaching to the tops of the tallest trees. It is also called the New Zealand lawyer.

SUPPLEMENTAL EDUCATION. Definition.—«Extension education is for every community and for everybody. It extends the opportunity for education to the whole body of the people, to the whole period of life and to all the vital interests of life.»

Formal education may be said to include the systematic instruction which is imparted through personal contact with the student, whether by class-room work or lectures, when given under the direct guidance and supervision of trained instructors in schools, colleges, universities and similar institutions, as distinguished from knowledge acquired through the more informal methods of study whether or not allied with teaching institutions. These methods vary widely and range from the carefully organized study clubs of university extension courses to the entirely independent research work of single individuals in libraries, museums and similar educational institutions.

General Purpose.—«Universities exist for two purposes: (1) To perpetuate and discover knowledge; (2) to disseminate that knowledge both in its academic and its practical results. Extension teaching furnishes a means of furthering knowledge in both these aspects, particularly the practical.

«By instituting popular instruction in those practical, technical and cultural subjects over which universities tend perhaps unconsciously to exercise a monopoly those institutions can so influence public taste and intelligence as to contribute greatly to social progress.» Nalder.

The chief object of extension work is to provide the best education possible at the lowest practicable cost for those who are unable to attend established educational institutions.

I. Systems.— University Extension.— *History.*—As early as 1831 some forms of university extension were in use in the United States in the work of the American National Lyceum, an organization which, though not associated with any educational institution, had a part in the wide spread of popular education. Lecture courses and debating clubs were begun in many city and country communities. In 1887 an address before the American Library Association on the subject of the English system of university extension aroused much interest, and as a result university extension work was begun in several cities in connection with the work of the city library. In 1889 Columbia University announced to the teachers in and near New York City the offer of certain elementary courses in science, to be given by means of classes outside the university. From this beginning university extension grew steadily as a power in popular education.

Purpose and Scope.— University extension provides a means for the acquirement of an education by those who for any reason are unable to attend institutions offering formal instruction. The courses are designed not only to assist such persons but also to supplement the regular work of such institutions by offering an opportunity for continued study to those who may have completed the formal courses.

Extension courses cover a wide range of subjects from those of a very elementary character to those which are of interest and benefit only to a highly educated and cultured class, the courses being adapted to the particular need to be met. In many instances it is difficult to make a clear line of distinction between university extension and the formal instruction of teaching institutions as exemplified in night schools and vocation schools.

Methods.— Extension service as carried on by the universities of this country varies widely in methods. In some institutions there is a separately organized extension faculty entirely distinct from the regular faculty, while in others extension work is conducted by the regularly organized faculties through the medium of the various departments. The former plan, which is relatively more expensive, provides for a highly specialized and intensive type of work, but the other secures co-ordination of effort by the various departments and co-operation on the part of the faculties that would otherwise be impossible.

1. Lectures and Classes.—More or less lecture work is offered in most of the institutions which do extension teaching. Several forms of such work are employed, in some cases all are used in the same institution while in other cases one form may represent the entire work of the institution along extension lines. One form of lecture work is the lecture class — often these classes are held on Saturdays or late in the afternoon of other days for the benefit of students who are fully occupied during the hours of the regular college classes. Frequently the lectures are given by members of the faculty, also by men engaged especially for the work and by local experts in particular lines. One of the chief developments in the establishment of local classes throughout the country has been in connection with engineering work. Classes have been formed in shops and factories, and short courses offered at a number of colleges and universities.

In California out of 300 classes held under the direction of the University of California in eight cities, more than 200 classes were in San Francisco alone, showing to what an extent extension service may contribute to the intellectual, industrial, social and commercial life of a great modern city.

«The welfare work of university extension is based upon the theory that there is a large field of human interests, specifically social in their nature, which is not covered by any other public educational agency. Such interests are those of health, municipal affairs, a public forum, the music interests of a community and the promotion of the economic prosperity of the small town. Many other topics might be mentioned but these are typical and are the more easily organized and directed.»

Extension work in home economics seeks to conserve the home through reaching and training the individuals who compose it. In the South there are nearly 1,000 women who are devoting their entire attention to 15 Southern States. South Carolina has 45 county agents and 20 cotton mill villages organized for community improvement.

The extension work of normal schools includes all forms of educational activity carried on by the normal schools among people who are not enrolled as resident students in the regularly organized classes. The extension work of these schools differs principally from that of the universities in that it lays special emphasis upon the study group or local class method, not upon correspondence work.

2. Study Clubs.— Some of the first steps in university extension were taken in the State of New York and it was the first State in this country to make university extension a part of its educational system. A special feature of the work was the development of the library system in all its branches. Through the traveling libraries division of the University of the State of New York collections of books were sent out as early as 1894 to university extension centres for the use of the study clubs formed in connection with the lectures. From this beginning has grown the present widespread use of the traveling libraries by hundreds of study clubs throughout the State.

3. Debating Societies.— The discussion of public questions of importance and interest has been encouraged and stimulated by the establishment of a service which supplies current information and data on live topics of the day. Package libraries consisting of books, pamphlets, clippings and typewritten material on important social, economic and political questions, on the principles of debating and on the organization and conduct of debating societies are supplied freely to schools, debating clubs and similar organizations. Local libraries co-operate by furnishing available material and in some instances, notably in the case of the New York State Library, the work is carried on directly under the jurisdiction of the library. This work has been very fully developed at the University of Wisconsin.

4. The Co-operative Plan.— The co-operative system has been defined as the co-ordination of theoretical and practical training in a progressive educational program. One of the reasons why the night school has not been able to cope with the problem of the illiteracy of the adult worker with entire success is because it frequently does not connect his education with his work. Co-operation between school and factory helps to solve this problem. This system, whereby manufacturers agree with the school authorities to carry on apprenticeship courses in practical trades while the school gives generalized and special instruction, has already met with practical success. In the co-operative plan the students frequently work in pairs; while one is at the office, shop or laboratory, the other is at school, the two changing places weekly. Courses are properly called "co-operative" because they enlist the active co-operation of the outside practical world in directing some of the educational policies of the school. At the present time there is a growing tendency on the part of manufacturers, department store managers and others to conduct, often during business hours, classes for their employees along the lines of their specific forms of business or on general elementary subjects of education. Such schools are described more fully elsewhere under the subject of Corporation Schools.

Principal Present Day Agencies.— Of the many institutions conducting university extension courses at the present time among the most notable ones are the University of Wisconsin, University of Michigan and Columbia University.

1. Wisconsin.— The University of Wisconsin offers several plans of extension work for the benefit of persons who desire to study any subject as members of a club, class or study group and provides special guided outlines. Such co-operative study makes possible personal visits and class instruction from university professors and specialists. These plans are adapted to the needs of teachers' groups, women's clubs, labor unions, farmers, business men's associations, etc. The outlines which are provided carry the privilege of a lecture or series of lectures and of direction, guidance and assistance by the person who outlined the work. Because of this provision the studies are much more effective and interesting. There is a nominal charge for outlines with the attendant privileges and the cost of lectures varies somewhat with the lecturer. Much work is done in supplying material for debates. The department of debating and public discussion has approximately 10,000 packages of material available for distribution and there is an increasing demand for this service. Recently a Chautauqua circuit has been established in the State for the purpose of providing instruction, inspiration and recreation.

Community institutes are held in various parts of the State to assist local communities to solve certain definite problems. These institutes are in charge of men specially trained in the economic and social problems common to small country communities.

The university in its extension work has free access to the Legislative Reference Department, the State Historical Library, the University Library and the City Library. The Wisconsin Free Library Commission and those in charge of the different libraries co-operate generously in this work. Bulletins are issued, bibliographies and study outlines are prepared and publications are supplied gratis in the State. The Wisconsin Civil Service Commission has co-operated with the university in educational work among State employees by means of conferences, talks, lectures and circulars.

2. New York City.— In New York city a plan is being followed of training persons already in the city public service through the co-operation of the College of the City of New York and the city government. In 1917 a thousand city employees were studying 1,300 courses in the evening classes. The College of the City of New York in co-operation with the board of education offers free extension courses in several centres to the teachers of the New York City schools.

3. Columbia University.— The extension teaching department of Columbia University offers many courses in subjects which form a part of the curriculum of Columbia College and in the more advanced branches of these subjects shares in the work for the higher degrees. Subordinate and subsidiary to this are the courses of secondary school grade for mature students who cannot return to ordinary schools of this type. The professional schools are represented in an increasing number of

courses so that students may pursue their studies in many special branches. In addition to the regular courses of the extension teaching department extramural courses in New York and in outlying cities are offered.

4. Other Agencies.— One that is attempting to reach working people along educational lines is the Young Men's Christian Association. The subjects pursued in the Y. M. C. A. classes may be approximately grouped under six heads: (1) Commercial; (2) political; (3) industrial; (4) scientific; (5) language and miscellaneous — music, first aid to the injured, etc; (6) special schools, such as law, art, automobile, etc.

The Young Women's Christian Association also has educational classes but comparatively little instruction is given in the regular high school subjects. The main effort is to help women who are self-supporting to become more efficient and to put within the reach of those who are not self-supporting the training which will enable them to become so.

The University of Michigan endeavors to conduct its extension service as far as possible through established university channels. Its policy is to render through its extension division the largest possible measure of public service commensurate with the equipment and facilities of the university. It is a condition that all extension lectures shall be free to the public and that they shall be so advertised. In one year 1,000 reprints were made for the 300 lectures offered. The total number of auditors reached throughout the State in the year was 71,500.

II. Home Education.— *Definition.*— There is no distinct line of demarkation between what is termed university extension and home education, but in general the former may be said to provide for the giving of instruction to groups or classes rather than to individuals. The work is conducted for the most part by teaching institutions by means of lectures and other methods which are not comprised within the lines of formal education. It is the extension of the teaching power of an institution beyond the boundaries of regular class-room work. Home education is that which can be acquired in the home independently of association in groups or classes. It embraces all means of obtaining knowledge which are individual in their nature as distinguished from education acquired through association with other individuals by means of classes, study clubs, lectures, etc. Correspondence schools, reading courses, libraries, museums and other similar sources all offer a means of securing an education without the formal instruction associated with class-room work.

Purpose.— A very large proportion of our population leave school before completing either the high school or grammar school course. Within a few years many of these people realize their educational limitations but because of age, hours of labor, financial condition or other reasons it is impracticable for them to resume a course of study in an educational institution. University extension courses and home education facilities are designed to meet the needs of such persons and of all who for any reason desire to continue their studies. The recent increase in the number of persons taking correspondence courses is the best testimony of the need of educational facilities to supplement those of our regular schools, colleges and universities. To obtain an education through individual effort without the personal guidance and inspiration of a teacher requires determination and perseverance, and those who take advantage of these supplementary educational opportunities show evidence of a real desire and serious purpose to acquire an education. There are certain benefits to be derived from formal class instruction which cannot be obtained in any other way, but the serious and ambitious student may find in the United States ample opportunity to pursue his studies in his leisure hours at little or no expense.

Methods.— 1. Libraries.— These are well termed «the people's university» for they constitute the most universal, most accessible and most economical source for self-education. They are storehouses of knowledge which is made readily available to readers by modern methods of classification, cataloging and indexing. Nearly all large libraries in this country are equipped with the latest and best bibliographical aids so that the student has every possible means of assistance at hand. Our libraries are great laboratories for research and are increasingly frequented by those seeking information on all sorts of subjects. Ordinarily only such restraints with regard to the use of the books are imposed as are necessary to protect the rights of readers, and serious students are frequently granted special privileges. Within recent years all libraries have become much more liberal in their service to the public and have been transformed into active rather than passive educational institutions. «There is a sense in which the school may be looked upon as a fairer test of community opportunity than the library. The school is compulsory; it impresses people most during their most impressionable period. On the other hand the library reaches old as well as young. Once established it remains as a centre for the distribution of knowledge and hence of opportunity.»

2. Traveling libraries.— In some States library facilities, to a certain degree at least, are at the disposal of every citizen even though there may be no library in his local community. This distribution of books is accomplished by means of traveling libraries in some cases and in others by sending books by parcel post or express from a central public library or agency such as a State library or library commission. In the State of New York both methods are in use, the traveling libraries having been in operation since 1893. These traveling libraries are small collections of books, usually in units of 25 volumes, which are sent anywhere in the State without charge on condition that the books shall be for the free use of the public. These libraries are intended primarily for communities without any free library facilities but under certain conditions they are sent also to small public libraries. There is a wide use of these libraries also by schools, study clubs and various organizations, and many «house libraries» of 10 volumes are borrowed by individuals. Institutions or individuals wanting only a few books for a month or less may procure them from the New York State Library by paying the return transportation charges. By means

of this library extension service any citizen of the State may secure books either free of all charge or at a merely nominal cost.

3. Reading Courses.— Reading courses on various topics are prepared and made available by libraries, schools, individuals and governmental departments of education and by means of these guides to study, the individual is enabled to inform himself fully on the subjects covered by the courses.

In the Home Education Department of the United States Bureau of Education work is carried on largely through personal correspondence and through the dissemination of reading courses. In 1917 there were 10 courses offered and approximately 100,000 copies of the printed outlines were distributed during the year. The bureau has been able to secure the co-operation of libraries and library commissions in bringing these courses to the attention of the public and in carrying on the work. About 6,000 persons are now enrolled in the National Reading Circle and certificates are granted to persons completing the courses.

4. Museums.— The rise of the museum as a new force in town, city, state and nation is one of the latest phases of educational evolution. The growing museum influence which during the past quarter of a century has been especially remarkable throughout the cities of the United States is largely due to what may be called the new museum idea, namely that the museum is not a negative but a positive educational force and that it has teaching qualifications peculiar to itself. The most important function of a public museum is that of usefulness to the public in an educational way. With the great resources at their command museums are working out plans of various kinds for the definite instruction of the public, such as study rooms, illustrated lectures in the museum or elsewhere, tours of the museum under trained and competent guides, and loan collections.

One of the most interesting and important developments is the Children's museum, or Children's room which is one of the results of the growing conviction that the museum is a public educational institution which should meet the needs of all ages and classes of people.

5. Correspondence Courses.—Certain universities have especially emphasized correspondence-study work. At those institutions where this form of instruction has had the longest trial statistics show that the students who take advantage of the opportunities offered by these courses to do a certain portion of the work required for a degree cannot be classed among those who are seeking easy methods for gaining credit but are earnest students as a rule, frequently doing considerably better work than the average class-room student.

The subjects offered are mainly cultural; those courses for which there has been the greatest demand include the languages, mathematics, history, education, political economy and technical subjects. A large number of biblical and theological courses are offered by some institutions.

Correspondence schools also play a large part in Home Education, but instruction by correspondence can never take the place of class instruction for it lacks the inspiration of personal contact. As a means of helping ambitious people along special lines, however, it has been and is of very great value. In the commercial schools the great bulk of examination and correction of student's work is done by clerks who are under the direction of experienced men, but the textbooks and questions to be answered are usually prepared by competent experts. The system is "business-like" and in the best of the schools it is fairly efficient and satisfactory to patrons. Extensive advertising and organized systems of branch offices contribute greatly to the financial success of these schools. The methods of the stock company schools may not commend themselves to the conservative person but the results accomplished have been in the right direction. Schools of this character are usually incorporated under State laws and are managed by a board of directors. It was from the Methodist camp-meeting that the correspondence school first came into being. The work at Chautauqua, N. Y., developed from a camp meeting and as a part of that work correspondence classes were conducted. These were begun in 1871 and appear to constitute the first complete plan formally announced in the United States for correspondence work. For financial reasons this branch of the work at Chautauqua was dropped in 1900, but through it the way had been marked out for others. The commercial possibilities of correspondence work were soon recognized, several business schools adding that feature to their resident work. Some of the largest of the commercial correspondence schools were established through the interest of certain publishing houses as a means of selling their books.

The largest of these educational schools is the International Correspondence Schools at Scranton, Pa. This institution is representative of the class of schools operated as commercial ventures by stock companies. A daily paper published in Shenandoah, in the coal-mining district of eastern Pennsylvania, had in the early 80's a department devoted to the education of miners in the principles of mining and from this beginning has grown the present great organization. These schools offer over 200 standard courses and an indefinite number of special and combination courses covering many branches of technical education. There are nearly 2,000 persons employed in the various departments of the schools in America alone and hundreds in other countries of the world. The schools have enrolled more than 1,850,000 persons, approximately 100,000 new students being enrolled each year. More than 500 experts, instructors and assistants, are occupied in writing and revising the International Correspondence Schools textbooks and in examining and correcting the work of students. To teach successfully by correspondence requires an entirely different kind of textbook from that used in the class-room and the International Correspondence Schools textbooks constitute the foundation of this system.

In regard to achievements of such institutions as the University of Chicago, Pennsylvania State College, University of Wisconsin and others of a similar type nothing but good may be said. They have carried the higher education to thousands to whom college walls were but a dream. From the University of Chicago correspondence study reaches literally every part of the world. Through the Correspondence Study Department the university offers a large number of the courses given in the classrooms of its different divisions, and all nonresident work for credit is conducted through this department. Each course is designed to be equivalent to the corresponding residence course and calls for an equal amount of work. No preliminary examination or proof of previous work is required of applicants for correspondence work. At the Pennsylvania State College correspondence courses are offered in agriculture, home economics and industrial education, free of charge to any citizen of the State. Students at the summer session are permitted to complete their work in certain subjects by correspondence at a nominal cost. At the University of Wisconsin 300 single courses are offered in 28 departmental lines and 70 of these courses are in engineering subjects. Each course is divided into units designated as assignments and each assignment represents six to eight hours of work. The instruction is carried on in three ways; by special lesson sheets, by correction of the exercises submitted, and by personal letters and other assistance where special needs are not otherwise met.

Education of Adults in Other Countries. —Schools for the education of adults originated in England through the Sunday School movement during the 18th century. The first adult school was opened in Nottingham in 1798 and has continued to the present day. The movement soon spread to other parts of the country and though providing secular instruction it was religious in its association. Parallel with these schools were classes in scientific and civic subjects. In 1851 the English government first made pecuniary grants to evening schools. At the beginning of the 20th century out of every 1,000 of the population of England and Wales about 23 persons voluntarily attended some form of evening class on week days. Several agencies have been influential in the development of this movement — namely the University Extension system, the National Home Reading Union, the Y. M. C. A., the Recreation Evening Schools Association and the Worker's Educational Association.

England had in 1918 a new education bill which provides for national oversight, national direction and compulsory attendance of children from five to 14 years of age, for part time continuation schools for those between the ages of 14 and 18, for medical inspection, physical training and more than 30 other incidental aids to democratic education — this bill will revolutionize education in England.

University extension as a means of carrying higher education to adults has had an unparalleled success in England and the progress of the movement has been remarkable. Instituted by the University of Cambridge in 1873, adopted by Oxford in 1878, with the work of the London Society for the Extension of University Teaching, which was founded in 1876, taken over by the reconstituted University of London in 1900 — these three universities are the world-wide acknowledged leaders of the movement. The original form of university extension teaching has not declined in England as it has in the United States. The characteristic features of the lecture system at local centres, with a class following the lecture and a final examination, have been maintained. Taking Oxford alone some 500,000 persons have attended the courses given in nearly 40,000 lectures by over 200 lecturers and nearly 30,000 students have been examined.

One of the most far reaching educational results of the war of 1870, with its great lesson of the importance of national education, was the law of 1873 passed in Saxony making attendance at continuation schools compulsory for three years (that is up to 17 years of age) in that kingdom. The Saxon law appears to have been justified by the experience of a generation. There is no doubt that in this matter of continuation schools, as in so many other fields of social organization, the adoption of compulsion has been facilitated by the habituation of the working classes to compulsory military service.

Adult education forms an important part of the educational work of Denmark also. Children of ability who can pass the required examinations are sent on from the communal schools to the middle school, gymnasium and university at State expense. Most other children go to work after five years at school but a fair percentage of them go to evening classes not only for technical training but also for higher education generally, and many attend University Extension lectures regularly for years after they leave school. «A great social-educational movement was started in Denmark in the late 80's. The primary object of this movement which was organized and is still worked by students of the Copenhagen University, with the cordial help of the professors, is to draw together the diverse sections of the community, to weave bonds of friendly sympathy between them and to spread the light among even the lowest sections. Students hold night schools in the Copenhagen communal day schools and give lessons there gratis to all the working men and women who care to go. There are more than 100 teachers and more than 2,000 are taught. On Sunday night there are free popular lectures by students and professors to which the working classes flock in thousands. The Danes boast that in their country there is no 'unenlightened class' and they do so with good reason.»

WILLIAM R. WATSON,
Chief Educational Extension Division, State Department of Education, Albany, N. Y.

SUPPLEMENTARY PROCEEDINGS are in the nature of a civil and equitable action whereby property of a judgment debtor may be reached, where said property cannot be taken under the usual process of execution; its object primarily is to discover the property of a judgment debtor which is subject to execution, and to learn if the debtor possesses or controls any property which is applicable to the satisfaction of the judgment. Any creditor who has reduced his claim to a judgment and issued execution thereon may institute supplementary proceedings, and the first creditor who does so and prosecutes the proceeding with due diligence obtains a prior lien on the assets of the debtor. Supplementary proceedings exist and are regulated according to the statutes in each State;

some jurisdictions afford much the same remedy through other means; many States do not allow the remedy against corporations. In some jurisdictions certain classes of property are exempt, as, for example, wages earned by the debtor within a specified time next before the institution of the proceedings, the period varying with the statute. Orders for examination in supplementary proceedings are granted by a judge having jurisdiction according to the statutes under which the right to maintain the proceeding is derived and may be held before a judge or referee appointed for the purpose; this order must be served upon the person to be examined and it may be set aside on account of any defect but otherwise must be complied with. If, from the examination, it appears that the judgment debtor has in his possession or under his control property or money by which a judgment may be satisfied, the judge may, in his discretion, direct the debtor or person holding said property for him to deliver the property to a receiver for the purpose of applying same to the judgment. One who disregards or disobeys the orders of the judge in these proceedings is subject to punishment for contempt.

SUPPLICANTS, the name assumed by the Presbyterian petitioners against the introduction of Archbishop Laud's Service Book and the Book of Canons into the Church of Scotland: as their petition had no effect the Supplicants in 1638 signed the National Covenant and Confession of Faith, which that year were ratified by the General Assembly: thereafter they were known as Covenanters (q.v.).

SUPPLY RAILWAYS. Under this designation are included all railways, except combat railways, that may be constructed or used for the supply of an army in the field. They may vary from a light portable track to a standard-gauge road. Their principal uses are to connect the army with its base; to connect permanent camps with the nearest existing railway; to form a belt line around a besieged place outside the field of observation; to form a belt line inside the line of defense of a besieged place; for the movable gun defense, and for a general supply line to supply an army in a permanent position. In extreme cases a railway may have to be constructed to supply an advancing army when local conditions preclude other means of transportation.

Regardless of the gauge, the same underlying principles govern the construction of all such lines, and having a plan for the operation and maintenance of an existing line of railway, it is easy to adapt it to the requirements of a temporary line. The principal considerations that govern in planning for such a line are (1) the amount of army supplies, troops and animals that must be handled; (2) the time that can be permitted for its construction; and (3) the amount of transportation necessary to place the railway supplies on the work which applies particularly to operations beyond the sea. This latter condition ordinarily necessitates a narrow-gauge railway for a supply railway in a country beyond the sea. Local conditions, such as a large supply of standard-gauge material and rolling stock, may render advisable the building of a standard-gauge railway for operations from a friendly land base; but where conditions extremely favorable to a standard-gauge line do not exist, a narrow-gauge railway will probably be decided upon in the general case of supply railways. The weight of the materials and rolling stock is so much smaller, the bridges can be so much lighter, and the earth work is so much less than for a standard-gauge road that the narrow-gauge railway is decidedly easier and quicker to build.

In case an official report is desired by the commanding general before he decides whether or not to construct the line, the entire survey and the estimates must be finished before the report is made. This report is accompanied by maps and profiles showing the routes considered and the final location decided upon, and the reasons therefor. It also shows the approximate cost of material and of civilian labor, the amount and cost of rolling stock and other equipment, the capacity of the line when it is completed and the time that will be necessary to complete the work as desired. In case it has been definitely decided in advance to build the line, the cost and time are only considered in that they must be kept as low as practicable, and the survey need not be completed before construction work begins. See MILITARY RAILROADS.

EDWARD S. FARROW,
Consulting Military and Civil Engineer.

SUPPOSITORY, a medicinal compound prepared in the form of a cone, sphere, or cylinder, for introduction into the rectum, urethra or vagina, there to be dissolved (melting gradually by the heat of the body) for the purpose intended, as action on inflamed mucous membrane, evacuation of the bowel, etc.

SUPPURATION, a morbid process in animal tissues which gives rise to the formation of pus. It is one of the destructive terminations of inflammatory action. The inflammatory leucocytes, instead of developing into fibre-cells and forming tissue, become developed into pus-globules, and the exudation breaks down more or less completely into a creamy fluid called pus, which consists of these globules floating in serum, the liquor puris. Pus-globules, as seen out of the body, are but little different in appearance from leucocytes. The leucocyte, when treated with acetic acid, displays the appearance of a nucleus in its interior, that appearance being usually regarded as the result of a shrinking of the protoplasm of which it is composed. The pus-globule shows more distinct trace of a membrane, and is frequently many-nucleated when treated with acid, a condition which Rindfleisch regards as indicating a tendency to degenerate and break down. Many of the corpuscles of pus display no difference in character from the blood-leucocytes, having only single nuclei, showing the same amœboid movements, and being in fact obviously the same things both in structure and function. Suppuration is not, in most cases, wholly a destructive process, but serves also as one of the usual modes of repair. The result of the process of suppuration is thus twofold, being in part destructive and in part constructive. Suppuration in the interior of the body usually terminates in the formation of an abscess; but in some cases the matter is diffused through the interstices of the part, and is termed diffuse inflammation.

SUPRALAPSARIANS, sū"pra-lăp-sā'rĭ-anz, those Calvinistic theologians who maintain the strict doctrines of Predestination, Election of Grace and Reprobation, namely, that the Creator for His own glory decreed the fall of man and the consequent introduction of sin into the world; and that the election of some to life everlasting and the damnation of others was made «beyond» (or before, *supra*) Adam's fall, and was in no way consequent on it or dependent upon it. See PREDESTINATION.

SUPRANATURALISM. See SUPERNATURALISM.

SUPRARENAL CAPSULES, two small, ductless glandular bodies situated at the front portion of the upper end of each kidney. They are generally classified with the spleen and similar structures as ductless glands. Each suprarenal capsule exhibits a yellowish color. That of the right kidney is somewhat of triangular shape, the left being of somewhat crescentic form. In some cases these bodies may be hardly recognizable on account of their minute size. Their average weight is from one to two drams. Each capsule is connected to its kidney by areolar tissue only, no vascular or other connections existing between the glands; and neither capsule has any outlet or excretory duct. They lie behind the peritoneum, or lining membrane of the abdomen, the front surface of the right suprarenal capsule being in contract with the under surface of the liver, the same surface of the left being in relation with the pancreas and spleen. The capsules derive their blood from the aortic, renal and phrenic arteries, and return their blood by the suprarenal vein, which receives its blood from the net-work of the medullary portion, and also partly from the cortical substance of the organ. The nerves of the suprarenal capsules are numerous, and are branches of the solar and renal plexuses and of the phrenic and pneumogastric trunks. The suprarenal capsules are present in all mammals, and are largest in *Rodentia*, and smallest, proportionally, in the whales, in which they are lobulated or divided into lobes. In birds they are of small size, and exist generally on the inner aspects of the kidneys. In sharks they exist as a single, long, lobular organ lying behind the kidneys; and in frogs and toads they appear as yellowish patches on the kidney. They are also lobular in sturgeons and other fishes, and in newts and *Urodela* generally. That these bodies may have some important function to discharge in connection with the blood-circulation of the embryo is a highly reasonable suggestion; but further than this general statement physiology cannot certainly proceed. Facts of much interest in connection with these bodies, however, have been observed in cases of Addison's disease (q.v.). The actual diseases to which these bodies are liable consists of hypertrophy or enlargement, atrophy or wasting, tuberculous degeneration, fatty disease and occasionally cancerous infiltration.

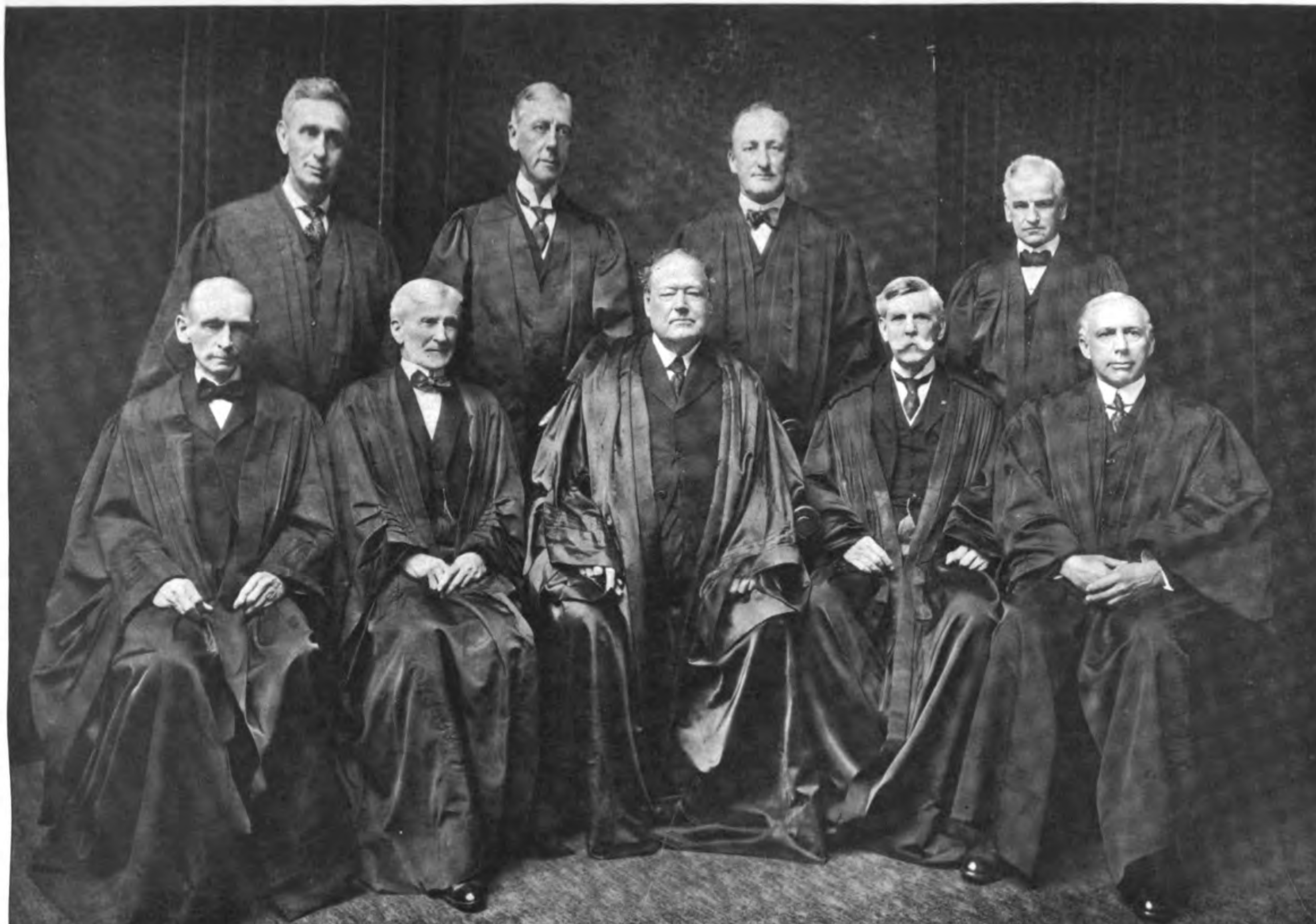
SUPREMACY, Royal, as a term in English law, is practically restricted to denote the authority of the Crown in matters ecclesiastical. After the abolition of the papal supremacy at the English Reformation, the royal supremacy was affirmed by various acts under Henry VIII and Elizabeth, all enforcing an oath of supremacy. The oath was taken by holders of public offices along with the oath of allegiance, and afterward with that of abjuration, until the three were consolidated in one. The revised oath of allegiance imposed upon members of Parliament does not expressly affirm the royal supremacy in ecclesiastical matters. Supremacy acts were passed in 1534, 1559 and 1689.

SUPREME COURT OF THE DISTRICT OF COLUMBIA. See COURT.

SUPREME COURT OF JUDICATURE, a legal tribunal in which are united all the higher courts of justice in England, exclusive of the appellate jurisdiction of the House of Lords and of the Privy Council. It dates from the Act of 1873. See COURT.

SUPREME COURT OF THE UNITED STATES, The, is a cardinal feature of our Federal representative government, balancing and harmonizing all its parts, a tribunal which has received the general approval and admiration of foreign jurists and statesmen, and commands the universal respect and confidence of the people for whom it administers justice. The Federal Convention of 1787, which framed our Constitution and created this unique tribunal, was composed mostly of members of the legal profession, which has always in America been the chief nursery of statesmen; but Washington, the soldier, presided and Franklin, the philosopher, advised at every step. The members of the convention were undoubtedly chosen from the best qualified men that the country could furnish for the momentous work which was set before them, and their merits have been so universally recognized that it is not necessary to repeat any of the emphatic tributes which many great Englishmen have paid to the results of their labors. Their work was finished in four months' secret session at Philadelphia, but most of them had been in training for it through 20 long years of trial and trouble. From 1765, the time of the passage of the Stamp Act, which was passed through both Houses of Parliament with little opposition, the colonists, and especially the lawyers of the Colonies, had been careful and earnest students of the principles of free government.

In 1774, having exhausted in vain all appeals to king and Parliament for a redress of their grievances, they sent delegates to a Continental Congress to deliberate on the state of public affairs, and in this Congress, which lasted for seven years, many of the future framers of the Constitution who were members of it found a most instructive school of statesmanship, and constantly devoted themselves to the social and political education of the colonists in matters of government and of public law and popular rights. In 1776, as the representatives of the United States of America in General Congress assembled, appealing to the Supreme Judge of the world for the rectitude of their intentions, they did, «in the name and by the authority of the good people of the Colonies, solemnly publish and declare that these United Colonies are, and of right ought to be, free and independent States; that they are, and of right ought to be, absolved from all allegiance to the British Crown; and that all political connection between them and the State of Great Britain is, and ought to be, totally dissolved.» They declared



THE SUPREME COURT OF THE UNITED STATES

Front Row (left to right) Justices Day, McKenna, Chief Justice White, Justices Holmes, Van Devanter
Back Row (left to right) Justices Brandeis, Pitney, McReynolds and Clarke

"that as free and independent States they have full power to levy war, conclude peace, contract alliances, establish commerce, and to do all other acts and things which independent States may of right do," and for the support of this declaration, with a firm reliance on the protection of Divine Providence, they mutually pledged to each other their lives, their fortunes and their sacred honor. From the hour of the Declaration, the men who made it, and all the other statesmen of the Colonies, had to give renewed and constant study to the whole science of government. As they proved able by force of arms to make good this declaration, the United Colonies became from its date a new nation, over which Congress, by general consent and acquiescence, exercised the powers of a general government, for all the purposes of the very serious exigency which had called it into existence. But it was a government by Congress only, with feeble and undefined powers, without an executive and without a judiciary. While the war lasted it barely sufficed, and afforded daily object lessons of its own defects and of what was required for a better government when better days should come.

The several individual States, being absolved from the royal charters under which they had before practically managed their own affairs, adopted written constitutions, based in each case upon the sovereignty of the people, to take the place of the former dominion of Parliament. An epoch of constitution making set in, during which the principles of representative popular government were discussed and understood. Virginia, the largest of the States, the home of Washington, Jefferson, Madison and Monroe, who were to be four out of the first five Presidents of the United States, took a leading part. New Hampshire had already framed a temporary form of government "during," as they said, "the unhappy and unnatural contest with Great Britain." South Carolina and New Jersey had followed, but in the case of the former it was expressly declared that the Constitution established was "established until an accommodation of the unhappy differences between Great Britain and America could be obtained."

Massachusetts, in 1780, with the utmost pains and deliberation prepared and adopted a complete Constitution, in which the powers of government were carefully distributed, with the solemn declaration that neither the legislative, executive or judicial department should ever exercise the powers of either of the others "to the end that it may be a government of laws and not of men." During the war the other colonies were engaged in the same business of founding States upon the principles of civil and religious liberty, embodied in written constitutions. Rhode Island alone, founded by Roger Williams, the great apostle of toleration, having received from Charles II in 1603 a royal charter, subsisted under it until 1842 without adopting any written Constitution.

But it was not only in the individual States that the framers of our Constitution were in all those years gathering knowledge and experience in the science of popular government. From the very date of the Declaration, Congress, conscious of the inadequacy of its powers, even for the purposes of carrying on war and conducting foreign affairs, entered upon the novel and difficult task of arranging a scheme which should enable it more efficiently to conduct those affairs which were of common interest to all the people of the 13 States, and which no one of them, nor all of them individually could control. After two years they adopted and submitted to the States what they styled "Articles of Confederation and perpetual Union," but it was not until March 1781 that the powers of Congress were enlarged by the final ratification of these articles by the delegates of all the States. But this attempted bond of union — a crude experiment in the formation of a national government — proved little better than a rope of sand, and utterly failed to accomplish the purposes intended. While the war lasted the tremendous pressure of their common danger and common distress kept the States together and made them obedient to the request of Congress which really had no power to command, but as soon as this external pressure was taken off, they fell apart, and each asserted its independent sovereignty. So jealous were the States, which had just escaped from the dominion of one central power, of anything which should seem to create dominion over them in another, that although upon paper they had laid many restraints upon their own action, and conferred upon Congress extensive powers over their Federal affairs, they had carefully refrained from giving any sanction to those powers and from granting to Congress the means of compelling obedience to its enactments. The Articles provided for no Federal executive and for no judiciary department, although they authorized Congress to provide for the settlement of boundary disputes between States and to appoint courts of prize and for the trial of piracies and felonies on the high seas. Moreover, Congress could not of its own authority raise a dollar of money for revenue or a single man to recruit its armies. It could only make requisitions for men and money upon individual States, which met them or not as they found it convenient. Nor could it proceed at all in the exercise of the principal powers nominally conferred upon it until nine States assented to the same. One of the leading writers of the time thus describes the powers of Congress under this Confederation:

"By this political compact the United States in Congress assembled have exclusive power for the following purposes, without being able to execute one of them. They may make and conclude Treaties, but can only recommend the observance of them. They may appoint Ambassadors, but cannot defray even the expense of their tables. They may borrow money in their own name on the faith of the Union, but cannot pay a dollar. They may coin money, but they cannot purchase an ounce of bullion. They may make war and determine what number of troops are necessary, but cannot raise a single soldier. In short, they may declare everything, and do nothing."

Judge Story says that, strong as this language is, it has no coloring beyond what the naked truth would justify, and even Washington himself wrote: "The Confederation appears to me to be little more than a shadow without the substance, and Congress a nugatory body, their ordinances being little attended to." Of course, under such a system our national affairs drifted steadily and rapidly from bad to worse. Interest on the public debt could not be paid, nor the ordinary expenses of government be provided for. The treaties which had been made could not be carried out, and foreign nations would not deal in the way of new treaties with the envoys of a body which had no head and no power to perform what they should agree to in its behalf. Our external commerce was at the mercy of foreign nations, whose laws contrived for its destruction, Congress could do nothing to counteract. And worst of all, our domestic commerce, which between all the citizens of one nation should be free and equal, was at the mercy of the caprice or selfishness of each individual State. There were many boundary disputes between States which threatened civil war. Federal laws were a dead letter, without Federal courts to expound and define their true meaning and operation, or an executive to see that they were properly executed. There was a general failure as yet to realize in actual enjoyment the advantages we had won by seven years of war, and everything seemed drifting toward bankruptcy, disunion and anarchy. But these very defects of the Confederation, and the evils which resulted from them, demanded the constant exercise of the best brains in all the States to understand and to remedy them, and opened a new school for all our statesmen in the study of constitutional government. When Washington had laid down his sword and surrendered his commission to Congress, after the signing of the treaty of peace which acknowledged the independence of the United States, he exhorted his countrymen by all they held dear to provide for the establishment of a strong and stable government as the only hope of retaining the liberties they had won; and from that hour until the Federal Constitution was made and ratified he and Hamilton, and Franklin and Madison, and all the other great statesmen who made it, or helped to secure its adoption, were engaged in the constant study of the principles of free government and in enforcing them upon the attention of their fellow citizens, so that they came to the performance of their great duties in the Federal Convention as graduates of the best practical school of Constitutional Law that the world has ever seen.

Their allotted task was to create a National Government which should reach, for its own proper purposes, by its own power, every man and every foot of territory in the whole United States, and should at the same time leave untouched and undiminished the complete control by each State of all its internal and domestic affairs — which should be entirely adequate without aid from the States, to govern the people effectively in all matters that involved the general interests of all, to deal with foreign nations with the whole power and resources of the entire people behind it, in all the exigencies of peace and war, and to accomplish all this with the least possible vesting of arbitrary power in any department or officer of the new government. They differed in opinion and sentiment on many points, but all agreed in a supreme dread of arbitrary power, whether it should be exercised by the executive, the legislative or the judiciary department, whether by a single man or by a majority of all, for they considered that the majority without any restrictions upon its power might become quite as dangerous as any other despot. They did not believe with my Lord Coke that absolute despotic power must in all governments reside somewhere. They carried this distrust of arbitrary power so far that they actually tied the hands of the people, whom they regarded as the source of all political power, and deprived them of the right to consider any amendment of the Constitution until it should be proposed by a vote of two-thirds of both houses of Congress or by a Convention called by Congress, on the application of the legislatures of two-thirds of the States, and deprived them of the power of voting directly upon any amendment, which could only be ratified by the legislatures or conventions of three-fourths of the States.

In other words, the people of the United States who ordained the Constitution, deprived themselves of the power to modify it by the direct vote of a majority or two-thirds or even three-quarters of their own numbers, whether that number should be 3,000,000 or 80,000,000. They must act deliberately and indirectly through Congresses, legislatures, conventions and primary elections. Truly a rare instance of political self-restraint at the basis of free popular government. One of the best definitions of the objects of such government is contained in the preamble of the Constitution:

"We, the People of the United States, in order to form a more perfect Union, establish justice, insure domestic tranquility, provide for the common defence, promote the general welfare and secure the blessings of liberty to ourselves and our posterity, do ordain and establish this Constitution for the United States of America."

It was to "establish justice" for the people of the United States that the Federal judiciary, with the Supreme Court as its head, was created. It forms the balance wheel by which the affairs of the nation and its relation to the States are kept in working order, and is itself held in check by the power of the President to appoint its members as vacancies may occur, and by the power of Congress to impeach them for misconduct, to regulate the measure of its appellate jurisdiction and to increase or diminish its numbers. The permanent stability of the judicial power is assured by its being imbedded in the Constitution, with a jurisdiction co-ordinate with that of the executive and legislative departments, by the extreme difficulty in the way of any amendment that would impair it, and by the universal conviction which the experience of a century has produced, that its continued existence with the full enjoyment of its present functions is absolutely essential to the successful working of our scheme of popular representative government.

The great achievement of the framers of the Constitution, was so to distribute the powers of government between the States and the Nation, as to give the latter supreme control over all subjects that concerned the general interests of all, and reserve to each of the former exclusive control over local affairs which concerned only its own territory and people, and to do this in such a way that the State and Federal administrations should not clash in actual operation. They knew well the importance of a distribution of the powers of government between the three great departments. They created a Congress on which they conferred legislative powers over 18 enumerated subjects, necessarily involving the general interests of the people of all the States and essential to national sovereignty, including the levying and collection of taxes for Federal purposes, the borrowing of money, the regulation of commerce with foreign nations and among the several States, the coining of money, declaring war, raising and supporting armies, and maintaining a navy. They placed such limits upon the exercise by Congress of legislative power as should prevent its interference with legitimate local administration by the States, or with the fundamental rights of the citizens, and put such prohibitions upon the legislative power of the States as should prevent their interference with the general powers and functions of the Federal government. They vested the executive power of the Federal government in the President, who was made commander-in-chief of the army and navy and of the militia of the States when called into the service of the United States. He was granted power to pardon offenders against the United States, to make treaties, provided two-thirds of the Senate concur, to have a veto power over acts of Congress, which could be overridden only by a vote of two-thirds on reconsideration. He was also to nominate, with the advice and consent of the Senate, ambassadors, judges and all the principal officers of the United States, to recommend to the consideration of Congress such measures as he should judge necessary and proper, to commission all officers of the United States, and to take care that the laws should be faithfully executed.

And, finally, to secure the absolute supremacy of the Federal government over all matters of Federal cognizance, it was expressly provided that «this Constitution and the laws of the United States which shall be passed in pursuance thereof, and all treaties made under the authority of the United States, shall be the supreme law of the land, and the judges of every State shall be bound thereby, anything in the Constitution or laws of any State to the contrary notwithstanding.» This making the Federal Constitution and treaties made, and laws of Congress passed under its authority, the supreme law of the land is the key of our dual system of government, as the omnipotence of Parliament is the key of the British Constitution. But the Federal government, though supreme within the limits prescribed, is not omnipotent; it must keep within those limits. By the 10th amendment, passed immediately after the adoption of the Constitution, to prevent Congress from meddling with the domestic concerns of the States, or exercising powers not granted to them, it was expressly provided that the powers not delegated to the United States by the Constitution, nor prohibited by it to the States, are reserved to the States respectively, or to the people.

Thus the people of the United States created for themselves two separate and distinct governments, each «of the people, by the people, and for the people,» each independent and exclusive of the other within its own scope and sphere, and each able, without aid from the other, to reach for its own purposes, by its own authority, every person and every foot of land within its territory. Complex as it may appear to people living under other forms of government, this dual system has worked very simply, smoothly, and harmoniously from the beginning until now, except for the single occasion when the terrible question of slavery proved to be too much for all the departments of government combined, and could only be settled by our long years of Civil War. But how has this marvelous result been accomplished? How has it been possible for these two governments, each of prescribed and limited powers, and each department of both similarly defined, to act independently and at the same time harmoniously over the same people? By what magical force has each power, State and Federal, been kept within its own limits? What has prevented constant and hopeless conflict between State functions and officials, and Federal functions and officials, between State and Nation, and between State and State, originally 13 in number and now 48? How has it been possible to secure the due protection of the law to the citizens of one State in each of the other States, and the rights of aliens against local prejudice and discrimination in any State, and how has the faith of treaties been preserved in every locality? These, and a thousand other similar questions and doubts as to the successful working of our system, are answered by pointing to the Supreme Court created by the Constitution, and to the Federal courts inferior to it created by Congress, in which the judicial power of the United States is vested, a power which, as has been said, is co-ordinate and co-extensive with the executive and legislative. Over whatever region Congress may attempt to legislate or the President to execute its laws, there the judicial power extends, to pass, if need be, upon the legality of their acts and the validity of their laws. The Constitution, and each of its provisions, is supreme over President, Congress, Courts and States, and the valid laws of Congress, and treaties made under the authority of the United States, are the supreme law of the land for all its people, and for the courts, legislatures, and governors of each State. The Supreme Court is the final judge of the validity of all laws passed by Congress or by the legislatures of each of the 48 States, when brought to the test of the Constitution of the United States, and of the legality of all official acts when brought to the same test. It and the Federal courts inferior to it furnish the vehicle by which the judicial power of the United States is carried into the whole of its vast territory, to administer justice within the limits prescribed to it, to enforce the Federal laws and to punish offenders against them.

The third article of the Constitution is marvelously brief and simple. The judges, according to that good old rule which has worked so well in England since the days of William and Mary, are to hold their offices during good behavior, and can only be removed by impeachment, and their compensation shall not be diminished during their continuance in office. The Supreme Court has original jurisdiction only in cases affecting ambassadors, public ministers and consuls, and in those in which a State shall be a party. The first branch of this original power has seldom been invoked, but over and over again a great State has been brought to its bar by another State to settle boundary disputes, always the most dangerous to the peace of adjoining States, and in each instance its decree has been submitted to with implicit obedience — a most unique judicial power, and a most convincing example to persuade all nations to settle these most perilous questions by arbitration. It has been well said "that the provision that the judicial power created by the people shall be the arbiter between the States themselves, in all their controversies with each other, marks the highest level ever attained in the progress of representative government." Tocqueville says: "In the nations of Europe the courts of justice are only called upon to try the controversies of private individuals, but the Supreme Court of the United States summons sovereign powers to its bar." John Stuart Mill declares it to be "the first example of what is now one of the most prominent wants of civilized society, a real international tribunal." In all other matters the jurisdiction of the Supreme Court is only appellate. The judicial power extends only to cases as they arise between party and party, and in the Supreme Court as they come to it mostly by appeal from the inferior Federal courts, or by writ of error to the State courts.

The courts of the United States exercise no supervision over, or interference with the President or Congress, or the legislatures of the States. They have no veto power. They do not lie in wait for acts of Congress, to strangle them at their birth. They have no jurisdiction to pronounce any statute, either of a State or of the United States, void because irreconcilable with the Constitution, except as they are called upon to adjudge the legal rights of litigants in actual controversies. They simply pass upon the rights of parties as they come before them, and if a provision of the Constitution, or of a Federal statute, or a treaty is invoked for or against a right claimed or denied, they interpret the Constitution, the law, or the treaty, and determine the right. In this way, and in this way only if an act of Congress or of a State legislature is claimed to be invalid, or an official act is claimed to be illegal under the Constitution of the United States, and the decision of that question is vital and necessary to determine the rights of the parties, they perform the ordinary duty of interpretation, and declare the validity or invalidity of the act, and so determine the right between the parties before them in that particular case, and for no other purpose, and this may happen months or years after the enactment of the statute.

The Supreme Court performs no duties except judicial duties. So, when in 1794 President Washington requested the opinions of the judges on the construction of the treaty with France of 1778, they declined to comply, and when an early Congress enacted that certain pension claims should be considered and passed upon by the Federal courts, the Supreme Court upheld them in refusing to act under it, upon the ground that the power proposed to be conferred was not judicial power within the meaning of the Constitution. Nor will the court give a hearing to a fictitious or collusive case, contrived to raise a question as to the validity of a statute. Keeping strictly within the limit prescribed to it of exercising only judicial power, the Federal judiciary has steadily refrained from exercising any political power, which belongs exclusively to Congress and the President, and so it has been brought into no collision with the other departments. It will not even indulge in discussions, or express opinions upon purely political questions. All attempts, for instance, to induce it to interfere either to restrain or compel the President in the exercise of his power to see that the laws are faithfully executed have failed. In the case of foreign nations, as well as in that of the sovereign States of the Union, the government acknowledged by the President, or by the President and Congress, is always recognized by the Supreme Court. In all such questions as are purely political it holds itself bound by the acts of the other departments. So the question whether and upon what conditions aliens shall be excluded from the United States, belonging to the political departments of the government, the court refused to express any opinion upon the wisdom, the policy, or the justice of the measures enacted by Congress in the exercise of the powers confided to it by the Constitution over that subject. Thus it constantly sets the example to each of the other departments of the government of minding its own business, and keeping strictly within its assigned province. But, careful as the judges are to confine the exercise of the Federal judicial power to cases as they arise, that power does extend to "all cases of law and equity arising under the Constitution, the laws of the United States, and treaties made under their authority, to all cases affecting ambassadors, other public ministers and consuls, and to all cases of admiralty and maritime jurisdiction"; and whenever any such case does come before the Supreme Court it must take cognizance of it, and it cannot shrink, and never has shrunk, from determining the question of private right so arising. It is under these clauses that its unique and peculiar function of testing the validity of State laws and constitutions and of Federal statutes, and the legality of the acts of State and Federal officers arises.

The remainder of the Federal judicial power depends wholly upon the character of the parties to the controversy. It extends "to controversies to which the United States shall be a party." This enables the Federal courts to enforce the acts of Congress, civil and criminal, against all persons within the realm; "to controversies between two or more States," the purpose of which has already been indicated, as making the Supreme Court the arbitrator and peacemaker between sovereign States; to "controversies between a State and citizens of another State, between citizens of different States, between citizens of the same State claiming lands under grants of different States, and between a State, or the citizens thereof, and foreign States, citizens, or subjects." It was wisely concluded that in all such cases justice would be safer and surer, against State or local interest, prejudice or passion, in courts representing and vested with the authority of the whole nation, than in the courts of the State of an interested party, and that foreigners especially should have the right to have their causes heard and decided by national tribunals. These clauses, which make jurisdiction dependent upon the citizenship or character of the parties, have been a prolific source of litigation in the Federal courts, have opened to them the entire field of law and equity; have extended their adjudications to the whole body of jurisprudence, and have given to the decisions of the Supreme Court, by reason of the weight and force of character of the court and its members, a commanding authority with the State courts, and persuasive influence with foreign tribunals. But in this department of its functions the Supreme Court does not differ, in the scope of its powers and duties, from the courts of last resort of other nations, and its distinctive and peculiar character is not involved. The power of the court to declare State and Federal statutes, and the acts of the National and State executive officers invalid, as being in violation of the Constitution of the United States, naturally attracts the attention of foreign observers.

In the 130 years of its existence the court has pronounced 33 acts of Congress, and more than 225 State statutes, to be in conflict with the Federal Constitution, and therefore invalid, and in each instance there has been complete and peaceful acquiescence in the decision. So that instead of being a disturbing element, the exercise of this power confirms the peaceful relation between the States and the Nation, and beween the States as among themselves, protects foreign nations from the breach of treaties, and conserves the rights of property and contract, and the fundamental rights of personal liberty. The Constitution provides that «no State shall pass any law impairing the obligation of contracts,» and the aid of the court has often been invoked for protection against the attempts of States to violate this prohibition. The framers of the Constitution believed, and the people of the United States, in view of the successful operation of this prohibition for more than a century, believe that the States ought not to be permitted to intervene between the parties to a contract, to destroy or impair the binding force of terms by which they have agreed to be bound, and that such intervention is contrary to the principles of popular government. It is true that in the days that tried men's souls before the adoption of the Federal Constitution many attempts had been made by States to intervene for this purpose, which doubtless led to the adoption of this clause.

Mr. Hamilton, in the *Federalist* classing such laws with bills of attainder and *ex post facto* laws, which are prohibited by the same clause, says:

"Laws impairing the obligation of contracts are contrary to the first principles of the social compact, and to every principle of sound legislation. They are prohibited by the spirit and scope of the State constitutions. Our own experience has taught us, nevertheless, that additional fences against these dangers ought not to be omitted. Very properly, therefore, have the Convention added this constitutional bulwark in favor of personal security and private rights. And I am much deceived if they have not, in so doing, as faithfully consulted the genuine sentiments as the undoubted interests of their constituents. The sober people of America are weary of the fluctuating policy which has directed the public councils. They have seen with regret and indignation that sudden changes and legislative interferences in cases affecting personal rights, become jobs in the hands of enterprising and influential speculators, and snares to the more industrious and less informed part of the community. They have seen, too, that one legislative interference is but the first link of a long chain of repetitions, every subsequent interference being naturally produced by the effects of the preceding. They very rightly infer, therefore, that some thorough reform is wanting which will banish speculations on public measures, inspire a general prudence and industry, and give a regular course to the business of Society."

In the celebrated Dartmouth College case the protection of this clause was invoked by the trustees of the college, to recover its property from a person who held it for new trustees under the authority of a law of the State of New Hampshire. In 1769, King George III by royal charter incorporated 12 persons, therein named as «The Trustees of Dartmouth College,» granting to them and their successors the usual corporate privileges and powers, and authorizing the trustees who were to govern the college to fill up all vacancies which may be created in their own body. The application by the founder, who had already established the college, was for a charter to incorporate a religious and literary institution, and stated that large contributions had been made for the object, which would be conferred upon the corporation as soon as it was created, and on the faith of the charter the property was conveyed to it. After the Revolution (in 1816), the legislature of New Hampshire passed an act increasing the number of trustees to 21, giving the appointment of the additional members to the governor of the State, and creating a board of overseers with power to inspect and control the most important acts of the trustees. Admitting that the provision of the Constitution embraced only contracts which respect property or some object of value, and which confer rights which may be asserted in a court of justice, and did not refer to grants of political power or to acts creating institutions to be employed in the administration of government or of public property, or in which the State as a government was alone interested, the court after most mature consideration reached the conclusion, that the charter was a contract which secured to the trustees the property and control of the college — a contract made upon valuable consideration — for the security and disposition of property, and on the faith of which real and personal property had been conveyed to the institution, and, therefore, a contract, the obligation of which could be impaired without a violation of the Constitution of the United States. It held that the statute of New Hampshire did impair it, and was, therefore, void, and rendered judgment restoring the property and control of the college to the trustees who represented the founder. The opinions of Chief Justice Marshall and Judge Story are masterpieces of judicial reasoning, and the principles laid down by them have ever since prevailed. In 56 cases decided by the court, acts of State legislatures have been declared invalid in accordance with these principles, because they impaired the obligation of contracts, and it is not too much to say that, instead of having a disturbing or disintegrating effect upon civil society, these decisions have done more than any other single cause to inculcate a reverence for the law, and for the sanctity of the right of private property, which is one of the chief objects of free government.

It is true that the constitutional prohibition against laws impairing the obligation of contracts does not expressly apply to Congress. In the convention, Mr. Gerry, a prominent delegate from Massachusetts, made a motion that Congress ought to be laid under the like prohibition, but found no seconder. But in the amendments which were proposed by Congress at its first session, almost as conditions on which many of the States had adopted it and which were quickly ratified, other restraints were laid upon Congress which had the like effect. It was expressly declared that no person shall be deprived of life, liberty or property without due process of law, nor shall private property be taken for public use without just compensation, and Congress is bound by these prohibitions. No matter what the emergency, it cannot violate these fundamental principles of personal rights. The court has held that the United States cannot, any more than a State, interfere with private rights except for legitimate governmental purposes, that they are as much bound by their contracts as are individuals, that if they repudiate their obligations it is as much repudiation, with all the wrong and reproach that term implies, as it would be if the repudiator had been a State, a municipality or a citizen. But strict and earnest as the court has been in enforcing its constitutional prohibition against laws impairing the obligation of contracts, it has been ready to recognize and give full force and effect to the statutes of other nations which imposed no such prohibition on the law-making power.

The Canada Southern Railway Company, under its charter granted by the Dominion of Canada, had issued its bonds at a high rate of interest, and had sold them in New York to citizens of the United States, but getting into difficulties the company devised a scheme of arrangement, which was enacted by the Dominion Parliament, by which the interest on the bonds outstanding was scaled down to a lower rate without the consent of the bondholders, a clear case of impairing the obligation of a contract. The bondholders appealed to the Supreme Court, which held that the «Arrangement Act» was valid in Canada, and bound non-assenting bondholders there by force of the scheme; that as it did have that effect in Canada, the courts of the United States should give it the same effect, even as against citizens of the United States whose rights accrued in the United States before its passage; that there was no constitutional prohibition in Canada against the passing of laws impairing the obligation of contracts, and that, under these circumstances, the true spirit of international comity required that schemes of this character, legalized at home, should be recognized in other countries.

The clause of the Constitution giving Congress the power to regulate commerce with foreign nations and between the States, has been another fruitful source of business in the Supreme Court in the way of testing the validity of State laws. At the outset of steam navigation, the State of New York undertook to reward Robert Fulton for his invention and enterprise by an act giving him the monopoly of navigating by fire or steam all the waters within the jurisdiction of the State. Under this act the assignee of Fulton had commenced running a line of boats between certain ports of New Jersey and New York, and obtained from the State courts of New York an injunction to restrain the owners of an opposition line of boats, put on between the same ports, from entering the waters of New York State with their boats. But the Supreme Court held, upon appeal, that the New York enactment was in conflict with the power of Congress to regulate commerce, and with its acts in relation to commerce, and upon this ground vacated the injunction and established the right of all vessels to enter the port of New York under the authority of Congress. It was held that by virtue of the constitutional clause referred to, Congress had exclusive authority to regulate commerce in all its forms in all the navigable waters of the United States, their bays, rivers and harbors, and to make navigation free to all without and restraint or interference from any State legislature. By a long series of decisions that followed under the commerce clause the court, with inflexible firmness and far-reaching sagacity, established the absolute supremacy of the nation over the whole subject of commerce, navigation, travel and intercourse between the States, which went far to strengthen the power of the Union. At the same time they secured to the citizens of every State the full enjoyment of the privileges and immunities of citizens in all the other States, and also that absolute freedom of internal trade throughout the country which has so vastly promoted the prosperity of the people.

The influence of the court in maintaining the faith of treaties has been powerful and far reaching. By the treaty of peace with Great Britain, in 1783, it was agreed that British creditors should «meet with no lawful impediments» in the collection of their claims; and the Constitution said that treaties, like laws, made under its authority, should be the supreme law of the land. Various attempts had been made by several States, before the adoption of the Constitution, to impede or prevent the collection of such claims. The subject provoked bitter and exciting controversies, but the court, against the contention of John Marshall himself, then at the bar, held that the treaty was supreme, and equal in its effect to the Constitution itself, in overruling all State laws upon the subject, and that its words were as strong as the wit of man could devise to override all obstacles directed against the recovery of such debts. Of course, any such law passed by a State after the treaty contrary to its terms would be void.

Perhaps the most striking illustration of the power of the court to declare acts of Congress itself invalid, as contrary to the Constitution, was the celebrated Income Tax (q.v.) case. Congress in 1894 had passed a General Revenue Law, certain sections of which imposed an income tax upon all incomes exceeding a certain amount named. This tax was levied indiscriminately upon all incomes alike, from whatever source derived, whether from the rents of real estate, the income of invested personal property or from earnings. But the Constitution had ordained that direct taxes should be apportioned among the several States according to the numbers of their respective populations, in contradistinction to duties, imposts and excises, which should be uniform throughout the United States. It was contended by those who challenged the validity of the law, that taxes on rent, and taxes on the income derived from invested personal property, were direct taxes within the meaning of the Constitution, and that instead of being levied uniformly, man for man, throughout the United States, they should have been apportioned among the several States according to population. The difference was very considerable and substantial. The effect of the act, if sustained, would be to throw the principal burden of the tax upon a few large States, in which the relative proportion of wealth was in excess of the relative proportion of population, and to exempt the other States proportionally from their constitutional share of the tax. The opponents of the income tax also insisted that any inequality, which should arise from its being apportioned among the States according to population, was an inequality contemplated by the framers of the Constitution, and was intended to prevent an attack upon accumulated property by mere force of numbers. The court, against vehement and powerful opposition at the bar, and from a formidable minority of the members of the court itself, took this view, and declared the tax to have been laid unconstitutionally, so far as it affected incomes from rents and from invested personal property. And as the invalid portions constituted so large a proportion of the whole income tax levied by the act, that Congress could not be deemed to have intended to impose the rest without them, it further adjudged that all the income tax provisions of the act, which constituted a single and entire scheme, must be held void. There were some popular protests against the decision, and direful prophecies that it would disable the nation in future emergencies from raising the revenue it needed, but no such results have yet appeared. Congress, in its subsequent enactments, has conformed to the decision, and when the war with Spain came on, and an immensely enlarged revenue was needed at once, it found no difficulty in imposing taxes constitutionally and so successfully that, the year after the war closed, the Treasury was found to be burdened with so great a surplus that the entire body of war taxes had to be repealed at once. The same case contains a fine illustration of the power of the court to protect the States in the exercise of their legitimate power to manage their own affairs from interference by the Federal government. The income tax was levied also upon income derived from the interest upon bonds issued by municipal corporations, which were but civil divisions of the States, and the court held that as a tax upon the income of municipal bonds tended to cripple the power of the local authorities to raise money for the purposes of local government, it was not within the power of the Federal government to impose it, any more than it would be constitutional for the States to impair the power of the Federal government to raise money for Federal purposes by taxing its bonds.

By the adoption of the 14th Amendment (q.v.), to meet the conditions resulting from the abolition of slavery at the close of the Civil War, new restraints were imposed upon the States, the consideration of which has largely occupied the attention of the Supreme Court. It provides that "No State shall make or enforce any law which shall abridge the privileges or immunities of citizens of the United States; nor shall any State deprive any person of life, liberty or property without due process of law; nor deny to any person within its jurisdiction the equal protection of the laws." Doubtless this amendment was primarily intended for the protection of the newly emancipated slaves, especially in the States where they had so long been held in bondage, but in its language there is no distinction of race or color, and the court held that it could make no such distinction in its application, which must be made alike to all cases and subjects that came within the scope of its language in its natural meaning.

It must not be thought, however, from these numerous restraints imposed by the Constitution upon the power of the States, and the very considerable number of cases (exceeding 200 in all) in which the Supreme Court has pronounced their statutes invalid, that the court is biased against the States or inclined unduly to enforce the limits imposed upon them. On the contrary, it has been quite as jealous and careful to uphold and maintain the reserved rights of the States in all matters of local and domestic concern, and to protect them from violation by the Federal government, as it has been to maintain the exclusive province of Congress in national concerns against intrusion by the State legislatures. It has endeavored, with success, to maintain the just and exact balance of power between them as prescribed by the Constitution. As against the 225 cases in which State laws have been invalidated by its judgments, vastly more numerous cases will be found, in its reports, in which State laws have been maintained by it against attack on the ground that they involved a violation of the Federal restraints. If, then, it be asked — why has it only pronounced about 35 acts of Congress invalid on constitutional grounds; while 225 State laws have been condemned? the answer is that there are 48 States and only one Congress, and that the members and committees of Congress are much more familiar with the Federal Constitution than those of a State legislature, who naturally look first to that of their own State. It is notable, too, that the legislators of some States must be much more studious of the Federal Constitution than others, for while Louisiana, which became a State in 1812 and from its French origin has retained the civil law instead of the common law, has had 20 of its laws pronounced invalid for violation of the Constitution, Massachusetts, one of the original 13 States, has only suffered twice in this way in her whole history.

Congress is, of course, in the first instance the judge of the constitutionality of its own acts, and its members, being mostly lawyers, are familiar with the letter and spirit of the Constitution. The cardinal and wholesome rule of the court has been, not to pronounce either a State or Federal law invalid on constitutional grounds unless the violation is clearly established, that the presumption is in favor of the validity of a statute, and that this continues until the contrary is shown beyond a rational doubt. The Supreme Court has felt that one branch of the government cannot encroach on the domain of the other without danger, and that the safety of our institutions depends in no small degree on a strict observance of this salutary rule. It speaks volumes for the wisdom and caution of the court which is vested with this remarkable and fascinating power, that in so great a mass of State legislation, some of it crude and undigested, consisting of thousands of volumes, it has not found it necessary to exercise the power much more frequently. It has been a source of frequent wonder to foreign observers that a written Constitution, which was framed in the 18th century for 13 feeble States, with 3,000,000 of people of substantially uniform wealth or poverty, scattered along the Atlantic seaboard, and for whose government it was regarded as a precarious experiment, should be found to answer as well in the 20th century for the needs of a great nation of 80,000,000 in 48 States, occupying the breadth of the continent, with gigantic accumulations of individual and corporate property, with conflicting interests and sentiments, and wide differences of social condition. There was much debate in the discussions which resulted in the adoption of the Constitution, whether the government which it called into being could reach and control even a people that was expected to occupy the territory which the Treaty of Peace of 1783 secured to the United States, which extended only from the Atlantic to the Mississippi River, and from the lakes to the northern boundary of Florida. Since that time our territory has expanded more than four times, and now embraces insular possessions of vast extent, at enormous distance from the seat of government and half way round the globe.

The fundamental difficulties of time and space have been overcome by the triumphs of steam and electricity, wholly unforeseen and unexpected in 1787. but which now, in the case of the United States and Great Britain alike, have rendered possible the administration of government from London or from Washington on any portion of the earth's surface. At the time of the adoption of our Constitution it took about as long to travel the length or breadth of the then United States as it does now to go from New York to Manila, or from London to Peking, and orders of either government which then would have taken months to transmit, now reach their destination so as to be put in execution at the other end of the world in a few hours, and sometimes in a few minutes. But in our case, we can account for the fact that a written Constitution, instead of being torn asunder and left by the way as the nation expanded, as new and wholly unexpected conditions arose, has grown with the growth of the nation, like the hide of an animal from its birth to its maturity, so that it still embraces and covers the whole of our vast national life. We owe it, first, to the wisdom of its framers, who inserted in it only fundamental rules and principles, generally and briefly expressed, leaving it always to Congress to fill in and provide for all details; and secondly, to the vigorous and masterly manner in which the Supreme Court has exercised its essential and lawful function of construction. By this it has applied the whole instrument and each of its parts to new conditions as they arose, and has developed and strongly asserted the inherent powers of sovereignty intended to be vested in the government of the United States, and necessarily resulting from their existence as a nation. It was our happy fortune that for 34 years, in that critical period of our history which was to determine whether we were to be a great and powerful nation, adequate for all the needs of a first-class power in the world, or only a league of States like the old Confederation, we had the benefit of the broad and robust intellect of Chief Justice Marshall, to enforce the liberal principles of construction which the genius of Hamilton had laid down.

In a single paragraph he states the whole theory upon which the court has administered the Constitution, and fitted it to the growing wants and changing conditions of the nation:

"The Government is acknowledged by all to be one of enumerated powers. The principle that it can exercise only the powers granted to it is now universally admitted. But the question respecting the extent of the powers actually granted is perpetually arising, and will probably continue to arise, as long as our system shall exist. The powers of the government are limited, and its powers are not to be transcended. But the sound construction of the Constitution must allow to the National Legislature that discretion with respect to the means by which the powers it confers are to be carried into execution, which will enable that body to perform the high duties assigned to it, in a manner most beneficial to the people. Let the end be legitimate, let it be within the scope of the Constitution, and all means which are appropriate, which are plainly adapted to that end, and which are not prohibited, but are consistent with the letter and spirit of the Constitution, are constitutional."

Hamilton, in the *Federalist*, declared that "the judiciary is beyond comparison the weakest of the three departments of power; that it can never attack with success either of the other two; and that all possible care is requisite to enable it to defend itself against their attacks." Montesquieu, whose works, with Blackstone's, were the textbooks of constitutional liberty which the framers had constantly in hand, declared that "the judicial power is next to nothing." And it was said by another French publicist, "It has no guards, palaces or treasures, no arms but truth and wisdom, and no splendor but the justice and publicity of its judgments." But the Supreme Court, sustained generally by the confidence and affection of the people, has more than held its own. Keeping carefully within its own limits, it has for the most part labored to keep the other departments of government within theirs, and the powers of the States and of the nation from coming into conflict. In its hands the judicial power has been the force of gravitation which has kept each member of our Federal system in its proper orbit, and maintained the essential harmony of the whole.

The closing scene in the Federal Convention, which made the court in a way the guardian of the Constitution, will be ever memorable. After months of discussion, sometimes violent, more than once approaching the very brink of dissolution, in hopeless despair of coming to any agreement, at last the grand triumph of compromise and mutual concession was accomplished, and the members met to affix their names to the instrument. Hamilton, one of the youngest, acted as scribe, and after Washington had signed first as "President and Deputy from Virginia," inscribed on the great sheet of parchment the name of each State, as the delegates came forward in geographical order to add their names. When all had signed, Franklin, the oldest and most famous of them all, pointing to the sun emblazoned behind the chair in which Washington had presided through the whole struggle, said to those about him, «In the vicissitudes of hope and fear, I was not able to tell whether it was rising or setting. Now, I know that it is the rising sun.» After more than a century's trial of their work, the sun which Franklin saw is not yet near the zenith — much has been done, but vastly more remains to be accomplished, and it is still morning with our young Republic.

Consult Carson, H. L., 'History of the Supreme Court of the United States, with Biographies of all Justices' (2 vols., Philadelphia 1902); Curtis, B. R., 'Jurisdiction, Practice and Peculiar Jurisprudence of the Courts of the United States' (2d ed., Boston 1896); Moore, B. F., 'The Supreme Court and Unconstitutional Legislation' (New York 1913).

JOSEPH H. CHOATE.

SURABAYA, soo-rä-bī'ä (Dutch, SOERABAJA), Java, (1) the seaport and capital of the province of the same name on the north coast of the island of Java. The city is situated on the Strait of Surabaya, which separates Madura Island from Java. It is, next to Batavia, the most important port and commercial station in the Dutch East Indies, and has machine-shops, an arsenal, a mint, sugar and furniture factories, shipbuilding yards and foundries. It exports sugar, coffee and the various products of the region. Pop. about 150,000 including about 10,000 Europeans. (2) The province of Surabaya has an area of 2,327 square miles and a population of over 2,115,000.

SURAJAH DOWLAH, soo-rä'jä dow'la, the last independent nabob of Bengal, under whom was perpetrated the massacre of the Black Hole (q.v.). He succeeded his grandfather, Ali Verdy Khan, in 1756, and within two months of his accession found a pretext for marching on Calcutta. On the arrival of Clive and Admiral Watson he retreated to Moorshedabad, but was routed at the battle of Plassey (23 June 1757). He then fled up the Ganges, but was betrayed by a fakir, and was put to death by order of the son of Meer Jaffier, the new nabob. Surajah Dowlah's reign lasted 15 months, his age at the time of his death being barely 20.

SURAKARTA, soo-rä-kär'tä, a town in central Java, connected by rail with Samarang on the north and Surabaya on the east. It is the residence of the native sultan of Surakarta, who is a vassal of the Dutch government and is advised by a resident. The town (pop. 125,000) is the capital of his kingdom, a mountainous but in part very fertile region, with an area of 2,191 square miles and a population of about 1,100,000.

SURAT, soo-rät', India, a city in the Gujarat division of Bombay, extends for some distance in crescent form along the south bank of river Tapti, (spanned by an iron bridge) in a fertile valley. It is 160 miles by rail north of Bombay. The Nawab's palace lies within the confines of the fort. The remarkable buildings are four handsome Mohammedan mosques, two Parsi fire-temples, several Hindu temples, and a clock-tower (80 feet high). There is also an extensive bazaar, and a Hindu hospital for sick animals. The city in 1512 was burned by the Portuguese, again in 1530 and 1531. The English established themselves there in 1612, and the city came under British rule in 1800. Industry is limited to the manufacture of cotton and silk goods, shawls, etc., articles of ornamentation, jewelry and ivory objects, indigo and pottery. The exports are cotton and grain. The commercial importance of Surat was established in the 16th century, and it was the starting point for pilgrimages to Mecca. Its decline dates from the removal of the East Indian Company to Bombay. Fire and flood contributed subsequently to its decadence. It flourished during the American Civil War through its cotton export. Pop. about 115,000.

SURCOUF, sür-koof, Robert, French naval officer: b. 1773; d. 1827. Much of his life at sea was devoted to privateering and he was known as «the king of the Corsairs.» From 1798 to 1801 and from 1809 to 1811, he scoured the sea for English merchantment as Paul Jones did some years previously. His life was divided between building French ships on shore and scouring the high seas for English merchant vessels. It was his advice to Napoleon: «Attack rich England in her riches — in her merchant vessels; leave your ships of the line at home and send out light privateers!»

SURETY. See SURETYSHIP.

SURETYSHIP, a word derived from the French *sûreté*, from the Latin *securitas*, which means freedom from care. It signifies the obligation of a person to answer for the debt, default or non-performance of another, and to make good any loss occasioned thereby to the extent provided in the contract. The difference between suretyship and guarantee is an essential one, a contract of suretyship being a direct liability to the creditor for the act to be performed by the debtor, whereas a guarantee is liability only for the debtor's ability to perform this act. A contract of suretyship is an immediate and direct undertaking that the act shall be done, and if the act is not done, the surety becomes responsible at once.

The Constitution of the United States makes it impossible for any State to enforce a law which might be construed as impairing the rights of a creditor under a contract of suretyship, but like other contracts it may be vitiated and annulled through fraud or duress in the execution. The surety is entitled to such information both from creditor and debtor as will enable him to know the nature of the obligation which he is assuming, and if there is fraudulent misrepresentation or suppression of the facts with the purpose of obtaining his agreement to the undertaking the surety can obtain relief in a court of equity. On the other hand this relief would not be granted against innocent parties who had, without notice from the surety, incurred expenditure or assumed obligations on account of the existence of the suretyship contract. Of course in such a case the surety would have a right to redress from the creditor or debtor, or both, who had caused him loss by deceiving him.

It should be understood that there is no obligation on the part of the creditor or of the debtor to disclose all facts relating to the risk, but only those the withholding of which, if known to them, or either of them, would constitute intent to mislead. The surety, on the other hand, is expected to use reasonable judgment and precaution in making the contract. The presumption of law is that the suretyship, the surety's signature being admitted, is valid, and upon him rests the onus of attacking its validity, if he so desires.

The surety's responsibility cannot be changed or the contract modified in any manner without his consent, and should any change be made in the contract without such consent, the surety is discharged from his obligation. It does not matter whether the change would be advantageous to the surety or otherwise; he has a right to stand upon the original terms, and cannot be held responsible for any different terms. This applies also to any extension of the term of credit specified in the contract without the surety's approval in legal form.

Upon discharge of his obligation by the debtor, the surety is of course released. The surety is likewise released by tender of payment by the debtor and refusal to receive it by the creditor. In some States the surety is released if the creditor does not sue the principal upon request of the surety. Should the debtor default and the surety have to pay, the surety becomes entitled to all the rights and securities previously held by the creditor against the debtor. If there are several sureties, and the creditor's claim is enforced against one only, the latter can compel his cosureties to pay their several shares, and he also has a claim against the principal for the amount which he has expended in meeting the obligation. See GUARANTEE.

SURF-BIRD, a shore-bird (*Aphriza virgata*), having a distinct place of its own between the sandpipers and plovers. It is about 10 inches long, with the wing seven; dark brown above, lighter on the wing coverts, with white spots and stripes on the head and neck; upper tail coverts and basal half of tail white, the latter terminated with brownish black; under parts white, tinged with ashy in front, each feather having a brownish black crescent. The bill is about as long as the head, with vaulted obtuse tip and compressed sides; wings long and pointed. It is found on the Pacific Coast of North and South America, and in the Sandwich Islands, migrating from northern to temperate regions in winter and back again in summer. It is usually seen on the edge of steep rocks, among the retreating waves, searching for small mollusks and marine animals, allowing the surf sometimes to dash over it, whence the common name; its flight is short, with a quick and jerking motion.

SURF-CLAM. See CLAM.

SURF DUCK, or SURF SCOTER. See SCOTER.

SURF-FISH, one of the many small ovoid fishes of the family *Embiotocidæ,* related to the percoids, which abound upon the Pacific Coast of North America, where they are found numerously in the surf on sandy beaches, and in the mouths of rivers. They are often gayly colored, sometimes in extraordinary patterns of spots or bars; and are easily caught but not valued much as food. The most familiar one is *Amphisticus argenteus;* several others are locally known as the blue, black, red and white perches, the alfione, etc. All are viviparous.

SURF-SMELT, a small, eminently toothsome smelt (*Hypomesus pretiosus*), numerous along the coast of California and northward, where it spawns in the surf, and is caught in great quantities in nets. See SMELTS; WHITEFISHES.

SURFACE, Joseph, a character in Sheridan's comedy, 'The School for Scandal.' He is a mean hypocrite who affects great seriousness and sentimentality.

SURFACE. (1) A physical surface may be defined as formed by the boundaries or limiting portions of a given body. (2) A mathematical surface is the boundary between two given portions of space. It may be of various orders, a plane surface being of the first order, a quadric surface of the second order, etc. A surface through all points of which a straight line may be so drawn as to rest entirely within the said surface, is termed a ruled surface. The cone, conoid and cylinder are examples of this class. A surface is said to be of the *n*th order when it is intersected at *n* points, either imaginary or real, by a given arbitrary line. For a treatment of the subject, consult Eisenhart, L. P., 'Treatise on Differential Geometry on Curves and Surfaces' (Boston 1909); Michaelis, M. L., 'Dynamics of Surfaces' (New York 1914); Smith, Charles, 'Solid Geometry' (3d ed., New York 1891).

SURFACE TENSION, that property of liquids in virtue of which they tend to take such a form as to have the smallest surface possible. The name "surface tension" has reference to the fact that liquids, when freed from the action of gravity and other comparatively powerful forces, behave as though their surfaces were elastic membranes, which are everywhere in a state of uniform tension. Beginners in the study of physics often form the idea, from their textbooks, that this hypothetical tension is real and that the surface of a liquid really is membranous in nature, and subject to an actual, physical tension. This is not at all the case; for the behavior of the liquid is due to an entirely different cause, as will be understood by reference to Fig. 1. *AB* here represents a liquid surface, and *m m m m m* represents a molecule of the liquid, which is originally in the interior of the liquid, but which is removed from it in the manner illustrated by the successive figures 1, 2, 3, 4 and 5. Consider, first, the state of the molecule *m* in the position 1. It is here surrounded by the liquid on all sides, and the attractive influence that the other molecules of the liquid exert upon it is sensibly the same in all directions. The circle that is drawn about *m* represents a sphere whose radius is the "radius of sensible molecular attraction"; that is, it is equal to the (unknown) distance at which we may suppose that the attraction of one molecule of the liquid for another one ceases to be sensible. The attractive influence of those parts of the liquid which are external to this sphere being by hypothesis insensible, we may regard *m* as influenced solely by such molecules as are within a sphere of the radius shown. It is easily seen, therefore, that the attraction of the liquid for m will be the same in all directions (and therefore without any resultant effect), so long as the sphere remains totally submerged. But when the molecule m approaches the surface so nearly that a part of its sphere projects into the air as shown at 2, it is equally evident that the attractive force upon m is no longer the same in all directions. In order to make it so, we should have to cut off, from the bottom of the sphere at 2, a segment equal to the segment that projects into the air, as indicated by the little shaded area. The mass of fluid that lies between this shaded segment and the surface of the liquid is without any resultant effect upon

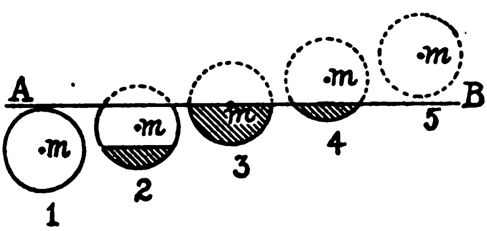


FIG. 1.

m, on account of its symmetry with respect to m; and hence in the position 2 we may regard m as subject only to the unbalanced downward attraction that the shaded segment exerts upon it. In position 3 the molecule has reached the surface of the liquid, and it is subject to a downward attractive force due to the mass of liquid contained in the entire lower half of the sphere. In bringing the molecule from position 1 to position 3, we therefore have to move it upward against a force which tends to pull it back into the liquid again; this force becoming active from the moment that the sphere of sensible molecular attraction first becomes tangent to the surface of the liquid; and increasing in magnitude until it attains its maximum value when the molecule actually reaches that surface. Hence we have to perform work, in order to transport a molecule from the interior of a liquid to the surface; and this amounts to saying that we have to perform work in order to increase the surface of a liquid. But this is just what we should have to do if the surface of the liquid were an elastic membrane; and hence it is permissible to imagine that the surface *is* such a membrane; and it is found that such a conception makes it easier to understand and describe the phenomena that result from molecular attractions in liquids. It will be noted, however, that in extending the surface of a liquid we do not actually *stretch* the existing surface. We merely bring more molecules from the interior, where the forces acting upon them are balanced, to the surface, where these forces are not balanced.

The phenomena of surface tension are most obvious in soap films and in foams, where the mass of the liquid concerned is so small (relatively to the surface) that the molecular forces which give rise to the so-called "surface tension" can easily preponderate over gravity, which is relatively powerful in liquid bodies of large mass and small surface. The French physicist Plateau devoted a vast amount of attention to the phenomena that are manifested by liquid films, and by masses of liquid that are freed from the influence of gravity by being suspended in other liquids with which they will not mix, but which have the same density as the liquid to be studied. Olive oil can readily be freed from the action of gravity, by submerging it in a mixture of alcohol and water, whose composition is regulated by trial until the mixture has precisely the same specific gravity as the oil. A mass of oil which is submerged in this manner, and is not constrained in any way, at once assumes a spherical form; for the sphere has a smaller surface than any other solid of the same volume.

The existence of surface tension can be shown readily and strikingly, even in a large mass of water, by several very simple experiments. Of these, the camphor-movement experiment is one of the best known. To perform it, a perfectly clean vessel is filled with clean water, some of the water being allowed to flow over the sides of the vessel, so that any superficial impurities may be washed away. Very fine scrapings of camphor are then allowed to fall upon the surface of the water; and if the water surface is sufficiently clean, these scrapings at once begin to execute the most violent movements. The motion of the camphor is due to the fact that the surface tension of a solution of camphor in water is less than that of pure water. The camphor particles do not dissolve evenly on all sides; and the horizontal pull exerted upon them by the water is greatest in those directions in which the concentration of the solution in immediate contact with the particles is least. Hence the motions. The great importance of absolute cleanliness in this experiment is well illustrated by touching with a slightly greasy finger a water surface upon which camphor particles are in rapid motion. The entire surface becomes contaminated almost instantly, so that the camphor movements become deadened, or cease altogether.

The effects of surface tension are observable in large masses of liquid, where those masses come in contact with the walls of their containing vessels. The slight elevation of the water in a drinking glass, where the water touches the glass, is due to this cause. This particular phenomenon is more marked in the case of a glass tube of small diameter, dipping in a vertical position into a vessel of water (or any other liquid which actually wets the glass). Let the glass tube be inserted into the water, so that it is wetted up to a certain level, and let the tube be then raised slightly. The glass, in the region which has been submerged below the general level of the water and is now raised above it again, adheres to the water, and as the tube is raised, the column of water within it sinks at the centre, so that its surface becomes concave, as is illustrated in Fig. 2. The weight of that part of the water within the tube which stands above the general level of the water in the external vessel (that is, the weight of that portion which lies between the actual water surface in the tube, and the dotted horizontal line), is sustained by the tension of the curved surface (or "meniscus") that bounds the column at the top; this tension acting everywhere in the direction of the surface of the water, and therefore having an obliquely-upward direction around the edges, and hence a vertical component, which is capable of sustaining the water in the tube. In the case of a liquid which does not wet the tube (for example, in the case of mercury and glass), the curvature of the liquid surface is in the opposite direction from that observed with water and glass; that is, the meniscus is convex upwards, as shown in Fig. 3, and the liquid in the tube

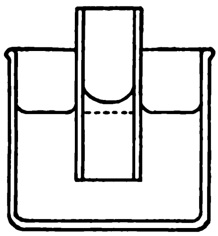


FIG. 2.

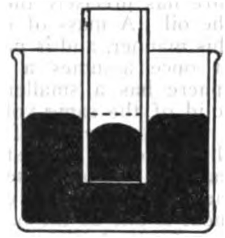


FIG. 3.

stands at a lower level than corresponds to the general level of the liquid surface in the containing vessel. In a barometer, the meniscus of the column is convex upward, and the depression of the column due to the surface tension of the mercury is usually quite sensible; so that in order to be in a position to know the exact height at which the mercury in the column would stand if the tube were large enough in diameter for the effects of surface tension to be negligible, it is necessary to investigate, very carefully, the way in which the depression varies with the diameter of the tube, and with the height of the meniscus itself. Numerous observers have made extensive investigations of this sort, and have given their results in tables. A very good table of this kind, due to Mendeléeff, is given in Guillaume's 'Thermométrie de Précision,' and other tables will be found in nearly all of the works upon meteorology. The property of liquids in virtue of which they stand, in a vertical tube, at an elevation different from that in the vessel into which the tube dips, is commonly called «capillarity,» in reference to the small diameter of the tubes in which the effect is most noticeable (Latin, *capillus*, «hair»).

TABLE OF SURFACE TENSIONS AT 20° C. (68° F.).

LIQUID	Dynes per centimeter	Grams per centimeter	Grains per inch
Water	81.	0.083	3.24
Mercury	540.	.551	21.58
Carbon disulphide	32.1	.033	1.28
Chloroform	30.6	.031	1.22
Alcohol	25.5	.026	1.02
Olive oil	36.9	.038	1.47
Turpentine	29.7	.030	1.19
Petroleum	31.7	.032	1.27

The surface tension of a liquid is measured by the horizontal pull that the liquid can exert upon a straight line one unit in length, lying in its surface; the pull being perpendicular, of course, to the direction of the line. The accompanying table contains the surface tensions of various liquids as determined by Quincke, and quoted by Maxwell. Mercury, for example, is capable of exerting a pull of 21.58 grains upon a straight line one inch long, lying in its surface. The value of the surface tension of water given in this table is certainly too great. Brunner found it to be 75.2 dynes per centimeter, and Wolf found 76.5 and 77.3. Rayleigh's determination, based upon a study of the wave-length of ripples, gave 73.9 dynes at 18° C.; and T. Proctor Hall found that at $T°$ C. the surface tension of water, in the same units, is given by the expression.

$$75.48 - 0.140T.$$

Bibliography.— Boys, 'Soap Bubbles and How to Make Them'; Plateau, 'Statique expérimentale et théorique des liquides soumis aux seules forces moleculaires'; Risteen, 'Molecules and the Molecular Theory of Matter.' Also, any extended treatise on physics.

ALLAN D. RISTEEN.

SURFACES, Theory of. Surface, in the mathematical sense, is the common boundary of two contiguous regions of space. The developments in this vast field of mathematical investigation are essentially of modern origin. The geometers of the Greek school were acquainted with some of the elementary properties of a few surfaces, notably those of sphere, cylinder and cone, but the systematic and fruitful study of surfaces began with their representation by means of equations in Cartesian co-ordinates (see GEOMETRY, CARTESIAN). This was not done until the method of co-ordinates had been employed with success in the study of plane curves, whereupon its application to surfaces presented itself as a natural extension. According to Cantor, 'Geschichte der Mathematik,' Parent (1666–1716) was the first to represent surfaces analytically by means of a single equation $F(x, y, z) = 0$. To each set of values of x, y, z satisfying this equation corresponds a point of the surface. With the introduction of co-ordinates two distinct phases in the study of surfaces present themselves. On the one hand the surface is defined in some purely geometric way, and the problem is to find an equation analytically representative of the surface. On the other hand an equation is assumed, and the problem is to arrive at the properties of the surface from its analytical definition. In the first case no less than in the second, the deduction of geometric properties proceeds, in the main, along analytical lines. It is at once evident that the second phase of the general problem greatly broadens the scope of investigation, and it is from this point of view that the mathematicians have studied the surfaces defined by algebraic equations of second, third, fourth and higher degrees. The algebra brings in imaginaries, and this leads to the introduction of surfaces that are altogether imaginary, and to the consideration of imaginary points and elements in connection with real surfaces.

In what has been said thus far the point has figured as the primitive element of the surface, and in connection with it the surface is a two-dimensional continuum of points. With the expansion of the subject additional primitive elements were introduced, viz., the plane and the line, and from the standpoint of the new elements the surface may be regarded as a two-dimensional continuum of planes, i.e., as the envelope of its tangent planes, or as a three-dimensional continuum of lines, i.e., the envelope of its tangent lines. The theory of a surface as the envelope of its ∞^3 of tangent lines constitutes a special chapter in the general theory of *complexes* of straight lines (see GEOMETRY, LINE, AND ALLIED THEORIES). Along with the analytical method, the synthetic or projective method has been employed, and with special elegance and completeness in the case of surfaces of the second order. With this brief introduction we now pass to a more detailed account of the developments in this branch of mathematics.

1. Algebraic Surfaces in General.—Any surface which can be analytically expressed by an algebraic equation between the Cartesian co-ordinates x, y, z of a point of space is called an *algebraic* surface. The *order* of the surface is the number of points of intersection (real or imaginary) of the surface by an arbitrary straight line. The order of the surface is obviously the same as the degree n of its equation. The *class* is the number of tangent planes of the surface that pass through an arbitrary line. When there is no singularity (see 7) on the surface the class is $n(n-1)^2$. The *rank* of the surface is the order of a circumscribing cone whose vertex is an arbitrary point of space. The rank is $n(n-1)$. The intersection of the surface by a plane is a curve of nth order, and, by the foregoing, the class of this curve is the same as the rank of the surface.

2. The Plane.—This is the simplest of all surfaces, and its equation in the variables x, y, z is of the first degree: $Ax + By + Cz + D = 0$, in which A, B, C, D are constants. It is the only surface of first order.

3. Surfaces of the Second Order, or Quadric Surfaces.—The earliest investigations were connected with the surfaces of the second order, namely, those defined by the general equation of the second degree:

$$Ax^2 + By^2 + Cz^2 + 2Fyz + 2Gzx + 2Hxy + 2Lx + 2My + 2Nz + P = 0.$$

This equation contains 10 coefficients which enter homogeneously. However, only the nine ratios of the coefficients are essential, as the equation may be divided through by any coefficient that is not zero. From this fact comes an important theorem. The substitution of the co-ordinates of a given point in the general equation imposes one equation of condition upon the coefficients; nine such equations determine the ratios of the coefficients, and herewith the equation, and with it the surface. The theorem follows: A surface of second order is in general determined by nine points through which it is to pass.

4. Classification of Quadric Surfaces.—There are in all 16 surfaces of the second order, when the purely imaginary and degenerate cases are included in the numeration. The grouping of the individual surfaces varies with the principle employed. The principle of division may be based on analytical criteria or on geometrical characteristics. Four different varieties of geometrical classification are known. In one the surfaces are divided into (*a*) the surfaces with centre or central surfaces, (*b*) the non-central surfaces. A second classification gives, (*a*) ruled surfaces with real generating lines (see 16), (*b*) non-ruled surfaces (analytically these latter surfaces are ruled surfaces with imaginary generating lines). A third classification rests upon the presence or absence of vertices on the surface. For example, a cone has a vertex and two intersecting planes are a degenerate form of a surface of second order with the line of intersection as a line of vertices. An ellipsoid is without a vertex. The fourth classification is based upon the nature of the conic that is cut from the surface by the plane at infinity.

We now present a classification based upon analytical criteria. This is effected by means of the values of two polynomials Δ and D, functions of the coefficients, and of the roots $k = \lambda, \mu, \nu$, of a cubic equation in k called the discriminating cubic. The polynomials may be conveniently put in the determinant form, as also the cubic equation:

$$\Delta = \begin{vmatrix} A & H & G & L \\ H & B & F & M \\ G & F & C & N \\ L & M & N & P \end{vmatrix}, \quad D = \begin{vmatrix} A & H & G \\ H & B & F \\ G & F & C \end{vmatrix}, \quad \begin{vmatrix} A-k & H & G \\ H & B-k & F \\ G & F & C-k \end{vmatrix} = 0$$

I. Surfaces for which $\Delta \gtrless 0$.

(α) $D \gtrless 0$, (i) Ellipsoid, real, if $\frac{D\lambda}{\Delta}, \frac{D\mu}{\Delta}, \frac{D\nu}{\Delta}$ are all negative.

(ii) Hyperboloid of one sheet if two of the quantities are negative.

(iii) Hyperboloid of two sheets if one of the quantities is negative.

(iv) Ellipsoid, imaginary, if all the quantities are positive.

These are surfaces with centre. By a suitable transformation of the co-ordinate axes to the centre the general equation can be thrown into the form $\lambda x^2 + \mu y^2 + \nu z^2 + d = 0$, in which $d = \frac{\Delta}{D}$ and λ, μ, ν are the roots of the discriminating cubic.

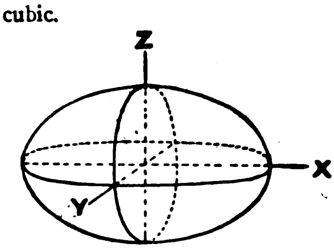


FIG. 1.—Ellipsoid.

(β) $D = 0$, (i) Elliptic paraboloid if λ and μ have the same sign.

(ii) Hyperbolic paraboloid if λ and μ have different signs.

When $D = 0$, one of the roots λ, μ, ν is zero, and it is here assumed that $\nu = 0$. By a suitable transformation of the origin of co-ordinates to a point of the surface, the equation may be made to take the form $\lambda x^2 + \mu y^2 + 2Qz = 0$.

The surfaces (α) *and* (β) *are surfaces without vertices.*

II. Surfaces for which $\Delta = 0$.

(γ) $D \gtrless 0$, (i) Cone, real, if λ, μ, ν are not all of same sign.

(ii) Cone, imaginary, if λ, μ, ν are of same sign.

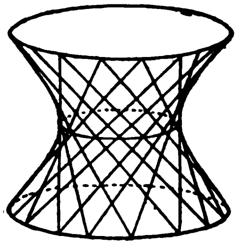


FIG. 2.—Hyperboloid of One Shee

By taking the origin at the vertex of the cone the equation may be brought into the form $\lambda x^2 + \mu y^2 + \nu z^2 = 0$.

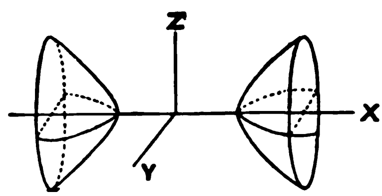


FIG. 3.—Hyperboloid of Two Sheets.

(δ) $D = 0$ (i) Elliptic cylinder, if λ and μ are of same sign and $d \gtrless 0$.

(ii) Hyperbolic cylinder, if λ and μ are of different signs and $d \gtrless 0$.

(iii) A pair of intersecting planes, real or imaginary, if $d = 0$.

(iv) Parabolic cylinder; or two parallel planes, real or imaginary (if all the subdeterminants of D are zero).

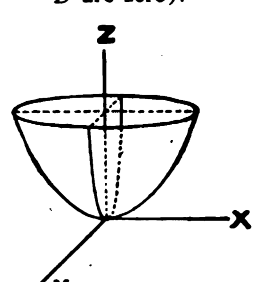


FIG. 4.—Elliptic Paraboloid.

For (i), (ii), (iii), the general equation admits of being thrown into the form $\lambda x^2 + \mu y^2 + d = 0$, and for the parabolic cylinder into the form $Ry^2 + Sx = 0$.

Since a cylinder may be regarded as a cone with infinitely distant vertex, and a pair of planes as a degenerate case of a cone, it follows that the surfaces (γ) and (δ) may be considered as cones, i.e., the *surfaces with vertex or vertices.*

The ruled surfaces among quadric surfaces fall into two categories: (1) the cone and cylinder, each containing one set of generating

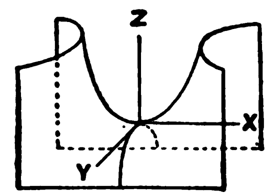


FIG. 5 —Hyperbolic-Paraboloid.

lines infinite in number; (2) the hyperboloid of one sheet and the hyperbolic paraboloid, each containing two sets of generating lines infinite in number. On the two last-named surfaces no two lines of one set intersect, but each line of one set intersects all the lines of the other set.

5. Surfaces of the Third Order, or Cubic Surfaces.—A considerable number of theorems about these surfaces are now known, though their properties have by no means been so exhaustively studied as in the case of quadric surfaces. There are two especially distinguishing properties to be noted concerning them: first, on the general surface there are 27 right lines; second, there is related to the surface a pentaedron whose edges and vertices lie on the *Hessian* of the surface. When there is no singular point on the cubic surface its equation can be thrown into the form $c_1W_1^3 + c_2W_2^3 + c_3W_3^3 + c_4W_4^3 + c_5W_5^3 = 0$, where $W_1, W_2, \ldots$ are linear in x, y, z and the equation $W_1 + W_2 + W_3 + W_4 + W_5 = 0$ holds identically. The Hessian of the cubic is

$$\frac{1}{c_1W_1} + \frac{1}{c_2W_2} + \frac{1}{c_3W_3} + \frac{1}{c_4W_4} + \frac{1}{c_5W_5} = 0,$$

a surface of fourth order. It contains the 10 edges and the 10 vertices of the pentaedron formed by the five planes $W_1 = 0$, $W_2 = 0, \ldots$ The vertices are double points (see 7) of the Hessian. For particulars as to these surfaces consult Salmon, 'Geometry of Three Dimensions,' and also Sturm, 'Synthetische Untersuchungen über Flächen dritter Ordnung' (Leipzig 1867).

6. Surfaces of Fourth Order.— Of these only special surfaces have been thoroughly discussed, among them the ruled surfaces and the Kummer surface. The Kummer surface contains 16 double points and 16 singular planes. Each of the planes is tangent to the surface along a conic and contains six of the double points, and through each double point pass six of the singular planes. Consult Salmon-Fiedler, Vol. II, and Kummer, 'Berliner Abhandlungen' (1866). The results obtained in the study of algebraic surfaces of order higher than the fourth are of more or less fragmentary character and need not be referred to in this brief sketch.

7. Ordinary and Singular Points.— In general the n points of intersection of a line and surface are distinct, but if a point P appears as k coincident points among the n intersections for *every* straight line through it, it is called a k multiple point of the surface. When $k = 2$ it is a double point, when $k = 3$ a triple point. Multiple points are singular points. Through a double point on a surface an infinity of lines can be drawn each of which will pass through a third point on the surface infinitely near the double point. The locus of these lines is a cone of second order. There are three cases: (1) the cone is a proper cone and the double point is called a *conical* point; (2) the cone degenerates into two intersecting planes and the point is a *biplanar* point; (3) the cone degenerates into two coincident planes and the point is a *uniplanar* point or *pinch* point. There may be a curve locus of double points on a surface: for example, the curve of intersection of a surface by itself is such a locus, as is also the curve of contact of two sheets of the same surface with each other. For a detailed study of the character of a surface in the neighborhood of a double point consult Rohn, 'Mathematische Annalen, 22' (1883). As the study of a surface proceeds in general from the equation of the surface, it is to the analysis we must look for a definitive criterion distinguishing ordinary and singular points. A point x_1, y_1, z_1 of a surface $F(x, y, z) = 0$ is said to be *ordinary*, if the F function is developable in an entire series in the neighborhood of x_1, y_1, z_1, and if the three first derivatives $\frac{\partial F}{\partial x}, \frac{\partial F}{\partial y}, \frac{\partial F}{\partial z}$ do not simultaneously vanish at the point. All other points are *singular* points.

8. General Considerations. Curvilinear Co-ordinates.— Modern progress in the theory of surfaces begins with the appearance in 1827 of Gauss' paper, 'Disquisitiones generales circa superficies curvas' (translated into German in Ostwald's 'Klassiker der exakten Wissenschaften'; into English by Morehead and Hiltebeitel, Princeton). Two things in this classical production have profoundly affected subsequent developments in the theory. The first was the systematic employment of curvilinear co-ordinates, and therewith a demonstration of the great advantages which could be derived from their use; the second was the conception of a surface as a two-way extension, *not rigid but flexible,* which could be made to assume new shapes by *bending without stretching.* All surfaces derived from a given surface by bending are said to be *applicable*, or *developable,* upon each other. It is clear that the geometry of figures on such surfaces is the same. The analytical criteria, whether two given surfaces are applicable upon each other, constitute one of the interesting chapters in the general theory. In expressing the Cartesian co-ordinates x, y, z as functions of two variables u, v called parameters:

(A) $\quad x = \phi(u, v),\ y = \chi(u, v),\ z = \psi(u, v),$

a new form of representation of surfaces is established. The elimination of u and v would obviously lead to one equation, $F(x, y, z) = 0$. If u be given a definite value u_0, and v be allowed to vary, a curve will be generated lying on the surface (see CURVES OF DOUBLE CURVATURE). The curve is called the u_0 curve, that is, it is named by the special value of the parameter that is constant at all its points. Assigning a second value to u, say u_1, and allowing v again to vary, there would be formed the u_1 curve of the surface. In this way there could be formed an ∞^1 of curves on the surface constituting the family of u curves. Similarly, there is a family of v curves each characterized by a definite value of v while u is variable. Each point of the surface is the intersection of a u curve and a v curve, and the curves are called its *curvilinear co-ordinates.* One may thus speak of the point (u_0, v_0) of the surface, or in general of the point (u, v), in place of referring to it by its Cartesian co-ordinates. Both co-ordinate systems are put in evidence by writing the point in the form $(x, y, z;\ u, v)$. A restriction upon the values u and v may take, such as an equation $f(u, v) = 0$, defines a curve on the surface.

9. Tangent Plane. Principal Normal Sections.— If to all the curves on a surface passing through an ordinary point $P\ (x, y, z;\ u, v)$, tangents be drawn at P, the line will lie in a plane called the *tangent plane* at P. Its equation is

$$\left(\frac{\partial y}{\partial u}\frac{\partial z}{\partial v} - \frac{\partial y}{\partial v}\frac{\partial z}{\partial u}\right)(\xi - x) + \left(\frac{\partial z}{\partial u}\frac{\partial x}{\partial v} - \frac{\partial z}{\partial v}\frac{\partial x}{\partial u}\right)(\eta - y) + \left(\frac{\partial x}{\partial u}\frac{\partial y}{\partial v} - \frac{\partial x}{\partial v}\frac{\partial y}{\partial u}\right)(\zeta - z) = 0.$$

where ξ, η, ζ are the current co-ordinates of the points of the plane.

The line perpendicular to the tangent plane at P is the normal of the surface at P. Every plane through the normal is a *normal plane,* and the sections made by them with the surface are *normal sections.*

10. The Fundamental Quadratic Forms and the Fundamental Magnitudes of the First and Second Order. The Fundamental Equations. —The entire theory of a surface is implicitly involved in two fundamental quadratic differential forms, and in three fundamental differential equations. The first form is the expression for the square of the arc length ds on the surface between two infinitely near points $P(x, y, z;\ u, v)$ and $P_1(x + dx, y + dy, z + dz;\ u + du, v + dv)$. This is found to be

(α) $\quad ds^2 = dx^2 + dy^2 + dz^2 = E du^2 + F du\, dv + G dv^2,$

where

$$E = \left(\frac{\partial x}{\partial u}\right)^2 + \left(\frac{\partial y}{\partial u}\right)^2 + \left(\frac{\partial z}{\partial u}\right)^2,$$
$$G = \left(\frac{\partial x}{\partial v}\right)^2 + \left(\frac{\partial y}{\partial v}\right)^2 + \left(\frac{\partial z}{\partial v}\right)^2,$$
$$F = \frac{\partial x}{\partial u}\frac{\partial x}{\partial v} + \frac{\partial y}{\partial u}\frac{\partial y}{\partial v} + \frac{\partial z}{\partial u}\frac{\partial z}{\partial v}.$$

The second quadratic differential form is the expression for twice the distance, d, from the point P_1 to the tangent plane at P:

(β) $\quad 2d = D du^2 + 2D' du\, dv + D'' dv^2,$

where

$$D = \frac{\begin{vmatrix} \frac{\partial^2 x}{\partial u^2} & \frac{\partial^2 y}{\partial u^2} & \frac{\partial^2 z}{\partial u^2} \\ \frac{\partial x}{\partial u} & \frac{\partial y}{\partial u} & \frac{\partial z}{\partial u} \\ \frac{\partial x}{\partial v} & \frac{\partial y}{\partial v} & \frac{\partial z}{\partial v} \end{vmatrix}}{\sqrt{EG - F^2}},\quad D'' = \frac{\begin{vmatrix} \frac{\partial^2 x}{\partial v^2} & \frac{\partial^2 y}{\partial v^2} & \frac{\partial^2 z}{\partial v^2} \\ \frac{\partial x}{\partial u} & \frac{\partial y}{\partial u} & \frac{\partial z}{\partial u} \\ \frac{\partial x}{\partial v} & \frac{\partial y}{\partial v} & \frac{\partial z}{\partial v} \end{vmatrix}}{\sqrt{EG - F^2}},$$

$$D' = \frac{\begin{vmatrix} \frac{\partial^2 x}{\partial u\, \partial v} & \frac{\partial^2 y}{\partial u\, \partial v} & \frac{\partial^2 z}{\partial u\, \partial v} \\ \frac{\partial x}{\partial u} & \frac{\partial y}{\partial u} & \frac{\partial z}{\partial u} \\ \frac{\partial x}{\partial v} & \frac{\partial y}{\partial v} & \frac{\partial z}{\partial v} \end{vmatrix}}{\sqrt{EG - F^2}}.$$

The six magnitudes $E, F, G;\ D, D', D''$ on account of their importance are called fundamental magnitudes: the first three as containing derivatives of the first order are called the *fundamental magnitudes of the first order:* the second three as containing derivatives of the second order are called the *fundamental magnitudes of the second order.* The six magnitudes are not independent of each other, but are connected by three partial differential equations called the *fundamental equations of the surface.* These may be obtained by differentiation from the foregoing equations. They are:

$$(\gamma)\quad \frac{DD''-D'^2}{EG-F^2}$$
$$=\frac{1}{2(EG-F^2)}\left(2\frac{\partial^2 F}{\partial u\,\partial v}+\frac{\partial^2 E}{\partial v^2}-\frac{\partial^2 G}{\partial u^2}\right)$$
$$+\frac{E}{4(EG-F^2)^2}\left[\left(\frac{\partial G}{\partial u}\right)^2+\frac{\partial E}{\partial v}\frac{\partial G}{\partial v}-2\frac{\partial G}{\partial v}\frac{\partial F}{\partial u}\right]$$
$$+\frac{G}{4(EG-F^2)^2}\left[\left(\frac{\partial E}{\partial v}\right)^2+\frac{\partial E}{\partial u}\frac{\partial G}{\partial u}-2\frac{\partial E}{\partial u}\frac{\partial F}{\partial v}\right]$$
$$+\frac{F}{4(EG-F^2)^2}\left[\frac{\partial E}{\partial u}\frac{\partial G}{\partial v}-\frac{\partial E}{\partial v}\frac{\partial G}{\partial u}-2\frac{\partial F}{\partial u}\frac{\partial G}{\partial u}\right.$$
$$\left.-2\frac{\partial F}{\partial v}\frac{\partial E}{\partial v}+4\frac{\partial F}{\partial u}\frac{\partial F}{\partial v}\right],$$

$$(\delta)\quad \frac{\partial D}{\partial v}-\frac{\partial D'}{\partial u}$$
$$=\frac{1}{2(EG-F^2)}\left[D\left(\frac{\partial E}{\partial v}G-\frac{\partial G}{\partial u}F\right)\right.$$
$$-D'\left(\frac{\partial E}{\partial u}G-\frac{\partial G}{\partial u}E+2\frac{\partial E}{\partial v}F-2\frac{\partial F}{\partial u}F\right)$$
$$\left.+D''\left(\frac{\partial E}{\partial u}F+\frac{\partial E}{\partial v}E-2\frac{\partial F}{\partial u}E\right)\right],$$

$$(\epsilon)\quad \frac{\partial D''}{\partial u}-\frac{\partial D'}{\partial v}$$
$$=\frac{1}{2(EG-F^2)}\left[D''\left(\frac{\partial G}{\partial u}E-2\frac{\partial F}{\partial v}F\right)\right.$$
$$-D'\left(\frac{\partial G}{\partial v}E-\frac{\partial E}{\partial v}G+2\frac{\partial G}{\partial u}F-2\frac{\partial F}{\partial v}F\right)$$
$$\left.+D\left(\frac{\partial G}{\partial v}F+\frac{\partial G}{\partial u}G-2\frac{\partial F}{\partial v}G\right)\right].$$

Equation (γ) was established by Gauss in the paper previously cited. The first member of this equation, $\frac{DD''-D'^2}{EG-F^2}$, has an interesting geometrical significance in connection with the curvature of the surface (see 12). Equations (δ) and (ϵ) were determined by Mainardi (1857) and 11 years later, independently, by Codazzi. The three equations are known as the *Gauss-Mainardi* or *Gauss-Codazzi* equations. It is evident that E, F, G satisfy the conditions: $E>0$, $G>0$, $EG-F^2>0$. To Bonnet is due the theorem that a surface is completely determined in all respects, except only as to its position in space, by six given functions E, F, G, D, D', D'' of two variables u, v, provided that the six functions satisfy the three fundamental equations (γ), (δ), (ϵ), and the three inequalities. The determination of the Cartesian variables x, y, z as functions of u and v, depends upon the integration of a differential equation of the Riccati type (see EQUATIONS, DIFFERENTIAL).

11. Curvature of Curves Traced upon the Surface Theorems of Mensnier and Euler. Principal Radii of Curvature.—The problem of the curvature of curves traced on the surface through P, and the relations of these curvatures, is simplified by considering first only those curves that have a common tangent at P. Let the common tangent be PT, and, for the sake of definiteness, let it be the tangent through $P(u, v)$ and the infinitely near point $P_1(u+du, v+dv)$. Conceive as drawn the sphere whose radius R and centre are the radius of curvature and centre of curvature (relative to P) of the normal section with the tangent line PT. *Mensnier's theorem* states that the plane of osculation of *any* curve through P with tangent line PT intersects the sphere in the circle of curvature of the curve relative to P. If τ is the angle between the plane of osculation of the curve and the normal section, and $\bar{R}$ the radius of curvature of the curve, then $\bar{R}=R\cos\tau$.

It remains to express the value of R. Newton's Theorem concerning curvature of plane curves gives immediately:

$$(\zeta)\quad \frac{1}{R}=\frac{2d}{ds^2}=\frac{D\,du^2+2D'du\,dv+D''dv^2}{E\,du^2+2F\,du\,dv+G\,dv^2}.$$

To each value of $\frac{dv}{du}$ correspond a tangent direction at P and a normal section, and the equation above determines the curvature of this section relative to P. There are two values of $\frac{dv}{du}$ for one of which R takes a maximum value, and for the other a minimum value. By the usual methods employed in maxima and minima the two values of $\frac{dv}{du}$ are found to satisfy the equation.

$$(\eta)\quad (FD''-GD')\left(\frac{dv}{du}\right)^2+(ED''-GD)\frac{dv}{du}+ED'-FD=0,$$

and the two corresponding values of R, viz., R_1 and R_2, the equation.

$$(\theta)\quad (DD''-D'^2)R^2-(ED''-2FD'+GD)R+EG-F^2=0.$$

The two tangent directions at P thus distinguished are at right angles to each other and are called the *principal directions of curvature at P*, and the corresponding normal sections are the *principal normal sections.* R_1 and R_2 are called the *principal radii of curvature* of the surface at P.

Euler's theorem expresses the radius of curvature R of any normal section in terms of the principal radii of curvature and an angle ϕ. The equation is

$$(\kappa)\quad \frac{1}{R}=\frac{1}{R_1}\cos^2\phi+\frac{1}{R_2}\sin^2\phi,$$

where ϕ is the angle between the normal section in question and the principal normal section corresponding to R_1. In Euler's and Mensnier's theorem the theory of the curvature of curves traced on a surface finds a satisfactory exposition.

12. Curvature of the Surface. Gauss Spherical Representation.— Various definitions of curvature of a surface have been suggested, of which three have found general acceptance. The three curvatures differ in kind. It is found that the mean value of the curvatures of all the normal sections through P (relative to P) is one-half the sum of the curvatures of the principal normal sections at P, viz., $\frac{1}{2}\left(\frac{1}{R_1}+\frac{1}{R_2}\right)$. It would be natural to take this value as the mean curvature of the surface at P, but the mathematical world has chosen to give the name mean curvature to the double of the quantity. Having regard to (ϑ), one has

(λ) *Mean curvature at a point*

$$=\frac{1}{R_1}+\frac{1}{R_2}=\frac{ED''-2FD'+GD}{EG-F^2}.$$

The other two curvatures are connected with Gauss's method of representing a surface upon a sphere by means of parallel normals. At a point P of the surface the positive normal is drawn; from the centre of the sphere a radius is drawn parallel to the normal; the extremity p of this radius is called the spherical image or picture of P. When P describes a curve on the surface, p describes a curve on the sphere, and, in general, to an area on the surface corresponds an area on the sphere. Gauss has called the area on the sphere the *total curvature* (curvatura integra) of the corresponding area on the surface. If $d\sigma$ is an infinitely small area on the surface above the point P and $d\sigma_1$ its total curvature, the ratio $\frac{d\sigma_1}{d\sigma}$ is called the *measure of curvature* (curvatura specifica) or *Gauss curvature* of the surface at P. Gauss showed that this ratio is $\frac{1}{R_1R_2}$, whence the theorem, that the measure of curvature at a point is equal to the product of the principal curvatures of the surface at the point. Using K to represent this curvature, and having regard to (ϑ),

(μ) *Measures of curvature at a point*

$$=K=\frac{1}{R_1R_2}=\frac{DD''-D'^2}{EG-F^2}.$$

13. Dupin's Indicatrix. Lines of Curvature, Asymptotic Lines. Conjugate Directions.— To ascertain the nature of the surface in the immediate neighborhood of a point P, one intersects the surface by a plane parallel to and infinitely near the tangent plane at P. The curve of section is called the *indicatrix* relative to P. The indicatrix is, in general, a conic whose equation is (β) when d is constant. As d is infinitely small of second order, the curve may be regarded as lying in the tangent plane at P with P as centre. Taking the tangents of the principal directions of curvature at P as co-ordinate axes (ξ_1, ξ_2), equation (β) becomes

$$\frac{\xi_1^2}{R_1}+\frac{\xi_2^2}{R_2}\,2d.$$

When R_1 and R_2 have like signs the indicatrix is an ellipse, and when the signs are unlike it is a hyperbola. In the first case P is an *elliptic* point of the surface and the neighborhood of P is *convex-convex* relative to the tangent plane; in the second case P is a *hyperbolic* point and the neighborhood of P is *convex-concave*. If either R_1 or R_2 is infinite at P, the indicatrix is *two infinitely near parallel right lines*. P is then called a parabolic point. A surface may contain a region of elliptic points and a region of hyperbolic points. The curve separating the two regions is a locus of parabolic points. For a surface of parabolic points, K must be identically zero (see 17).

By reference to the indicatrix at every point of the surface, one may define the system of *lines of curvature* as the two series of orthogonally intersecting curves (∞^1 in each series) whose tangent directions coincide with the principal axes of the indicatrix, i.e., with the principal directions of curvature (see 11). From the definition it follows that (η) is the differential equation of the lines of curvature. The integration of (η) for any surface whose fundamental magnitudes are known furnishes the two series of lines of curvature of the surface. It is characteristic of a line of curvature that the normals of the surface at two consecutive points of the curve intersect, and this property is sometimes given as the definition of the curve. By reference to this property a ready means is occasionally afforded for identifying the lines of curvature; for example, on a surface of revolution one of the series of lines of curvature consists of the meridian curves and the other series of the parallel circles. The sphere and plane form a class apart from all other surfaces as regards lines of curvature, for *any* curve on either surface is a line of curvature. To Joachimsthal is due the theorem that, if two surfaces intersect in a constant angle and the curve of intersection is a line of curvature on the one, it is also a line of curvature on the other. It follows in particular that, if a plane or sphere intersects a surface in a constant angle, the curve of section is a line of curvature.

Again, by reference to the indicatrix, one defines the system of *asymptotic lines* as the two series of intersecting curves whose tangent directions coincide with the asymptotes of the indicatrix. Asymptotic lines are real only in the hyperbolic region of the surface. The differential equation of asymptotic curves is (d=0)

(ν) $$Ddu^2+2D'du\,dv+D''dv^2=0.$$

It is characteristic of an asymptotic line that the plane of osculation at any point of it is the tangent plane of the surface at the point.

Two conjugate diameters of the indicatrix of a point give *conjugate directions* at the point; hence to *any direction* there is a conjugate. A system of curves consisting of two series of intersecting curves is *conjugate* when the above condition is satisfied at every point of intersection. In partial illustration of the foregoing definitions it may be remarked that all the points of a hyperboloid of one sheet are hyperbolic, and that the right-line generators are its asymptotic lines. On the anchor-ring surface, i.e., the surface generated in rotating a circle about a line in its plane, the curves described by A and B, the extremities of the diameter parallel to the axis of rotation, are curves of parabolic points; the inner surface of the ring is the region of hyperbolic points, the outer surface the region of elliptic points. The generating circle is in every position a line of curvature. It remains to define an *umbilic* as a point at which the indicatrix is a circle.

14. Isothermal Lines. Minimal Lines. Geodesic Lines — Curvature — Circles — Co-ordinates.— If the ds^2 of a surface assumes the form

(ξ) $$ds^2=a(u,v)[du^2+dv^2],$$

where $E=G=a(u,v)$, $F=0$, the parameter curves u = constant, v = constant, form an *isothermal* system (or *isometric* system) of curves. The parameters u and v are called *thermal* parameters. The distinguishing property of isothermal lines lies in this, that by their means the surface can be divided into a network of infinitely small squares. The division is effected by giving to u and v series of values in arithmetical progression, the two series having the same common difference ($du = dv$). The squares differ, in general, in magnitude. There is an infinity of isothermal systems on a surface, for the characteristic form (ξ) is reproduced in new parameters u_1, v_1, by making the substitutions

$$u + iv = f(u_1 + iv_1),\quad u - iv = f_1(u_1 - iv_1),$$

where f and f_1 are conjugate functions but otherwise arbitrary.

It is noted that (ξ) may be thrown into the form $ds^2 = a(u, v)[(du + i\,dv)(du - i\,dv)]$, and hence, by the substitutions $\lambda = u + iv$, $\mu = u - iv$, into the form

$$(\omega)\qquad ds^2 = \beta d\lambda d\mu,$$

where β is a function of λ and μ. The parameters λ, μ are conjugate imaginaries and the two series of corresponding curves on the surface are imaginary. They are called the *minimal* lines of the surface, as it is evident that along any one of them $ds^2 = 0$. The tangents of a minimal line are the minimal right lines (see CURVES OF DOUBLE CURVATURE). By integrating $ds^2 = 0$, one can determine the minimal parameters and thence a pair of isothermal parameters. Just as there is but one system of lines of curvature and one system of asymptotic lines, so there is but one system of minimal lines on a surface.

A *geodesic* line is a curve such that at every point P of it, the principal normal of the curve and the normal of the surface coincide. The shortest curve traced between any two points of the surface is a geodesic. A given geodesic does not always represent the shortest curve between any two of its points, but the property of shortest distance does hold for sufficiently small segments of the geodesic. On a surface of negative Gauss curvature (K negative at all points) a geodesic does not cease to be a curve of shortest length. On a surface of positive Gauss curvature (K positive), e.g., on a sphere, a geodesic may cease to be a shortest curve when prolonged. A string stretched on a surface lies in a geodesic; keeping one extremity of the string fixed at a point P and rotating about P, the second extremity of the string describes a curve called a *geodesic circle*. It is, in general, not a geodesic curve. If at P and P_1, two infinitely near points of an arbitrary curve c on a surface, geodesics be drawn tangent to the curve, the ratio of the angle between the geodesics to the arc length PP_1 is called the *geodesic curvature* of c at P. Obviously, geodesics are curves of zero geodesic curvature. The torsion of the geodesic tangent to c at P is called the *geodesic torsion* of c at P. A line of curvature is a curve of zero geodesic torsion at every point. The differential equation of geodesics, derived from the definition, is

$$(\rho)\quad \begin{vmatrix} E + F\dfrac{dv}{du} & \dfrac{1}{2}\dfrac{\partial E}{\partial u} + \dfrac{\partial E}{\partial v}\dfrac{dv}{du} + \left(\dfrac{\partial F}{\partial v} - \dfrac{1}{2}\dfrac{\partial G}{\partial u}\right)\left(\dfrac{dv}{du}\right)^2 + F\dfrac{d^2v}{du^2} \\ F + G\dfrac{dv}{du} & \dfrac{\partial F}{\partial u} - \dfrac{1}{2}\dfrac{\partial E}{\partial v} + \dfrac{\partial G}{\partial u}\dfrac{dv}{du} + \dfrac{1}{2}\dfrac{\partial G}{\partial v}\left(\dfrac{dv}{du}\right)^2 + G\dfrac{d^2v}{du^2} \end{vmatrix} = 0,$$

From the theory of these equations (see EQUATIONS, DIFFERENTIAL) it follows, that an infinity of geodesics may be drawn at any point of a surface, each determined by its direction at the point.

The expression for ds^2 takes a notable form when the parameter lines, $v = \text{constant}$, are geodesics and the parameter lines, $u = \text{constant}$, are their orthogonal trajectories. Two cases are of interest:

(1) The *geodesic parallel system*, in which the geodesics are drawn perpendicular to an arbitrary curve c as shown in Fig. 6, and t, t_1, . . ., are the orthogonal trajectories. Any two trajectories intercept equal lengths on the geodesics, and it is from this fact that the trajectories derive their name of *geodesic parallels*. If u represents the distance from c to a geodesic parallel measured on the geodesics, one has

$$ds^2 = du^2 + Gdv^2.$$

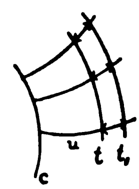


FIG. 6.

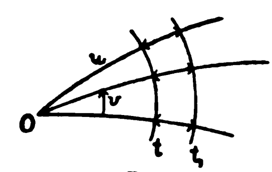


FIG. 7.

(2) The *geodesic polar system*, in which the curve c reduces to a point O as shown in Fig. 7, and the geodesics proceed from O. The orthogonal trajectories are geodesic circles. If u represents the distance from O to a geodesic circle, and v the angle from a fixed geodesic taken as a base, to any geodesic, there follows:

$$ds^2 = du^2 + Gdv^2,$$

where G is a function of u and v satisfying two conditions at the pole point:

$$\left[\sqrt{G}\right]_{u=0} = 0,\quad \left[\frac{\partial\sqrt{G}}{\partial u}\right]_{u=0} = 1.$$

We mention, finally, a system of references in which the curves are *geodesic ellipses* and *hyperbolas*. If a point P moves so that the sum (difference) of its geodesic distances from two arbitrary curves c, c_1 of the surface is constant, it describes what is called a geodesic ellipse (hyperbola); c and c_1 must not be geodesic parallels. Weingarten has shown that the system of geodesic ellipses and hyperbolas is orthogonal. A special case is when c and c_1 reduce to points. Liouville has investigated a class of surfaces on which there is an isothermal system of geodesic ellipses and hyperbolas. The form of the arc element is

$$ds^2 = \left\{f(u) + g(v)\right\}(du^2 + dv^2),$$

and the differential equation of the geodesics can be integrated and brought to the form $\displaystyle\int\frac{du}{\sqrt{f(u) + a}} - \int\frac{dv}{\sqrt{g(v) - a}} = b$, where a and b are constants of integration. Surfaces of the second order and surfaces of rotation belong to the Liouville surfaces. Gauss established the theorem that the sum of the angles of a geodesic triangle (the sides are geodesic lines) is greater than, less than, or equal to, π, according as the triangle lies in an elliptic, hyperbolic or parabolic region. The only surface that can contain an area of parabolic points is a developable surface (see 16), i.e., a surface developable upon a plane.

15. Representation of One Surface upon Another Surface. Conformal Representation. Applicability.— In map drawing one has an instance of the depiction or representation of one surface upon another. To each point of one surface corresponds a definite point of the other surface. The character of the depiction is a matter of the law of relation of the corresponding points of the two surfaces. If the equations of a surface A are expressed in parameters u, v and those of surface B in parameters, u_1 v_1, any equations $u_1 = g(u, v)$, $v_1 = h(u, v)$ will give a law of correspondence of points, provided that to a pair of values of u, v there corresponds a pair of values u_1, v_1, and conversely.

When each *infinitely small triangle* on the one surface is depicted in an *infinitely small and similar triangle* on the other surface, the depiction is said to be *conformal*. It follows that corresponding angles on A and B are equal; also that $ds^2 = kds_1^2$, where ds is arc length on A measured from a point P, ds_1 the corresponding arc length on B and k a quantity depending on the position of P and independent of the direction of ds. The analytical side of conformal representation is completely resolved by recourse to thermal parameters. The arc element of A in the thermal parameters u, v is $ds^2 = a(du^2 + dv^2)$; similarly, arc element of B in the thermal parameters u_1, v_1 is $ds_1^2 = \beta(du_1^2 + dv_1^2)$. The relations

$$u_1 + iv = f(u + iv),\ u_1 - iv_1 = f_1(u - iv),$$

where f and f_1 are arbitrary conjugate functions establish a conformal representation, since, by virtue of these relations, $ds^2 = kds_1^2$. Any two surfaces can, in general, be conformally represented upon each other in an infinity of ways. The functions f and f_1 can be chosen to furnish the most advantageous conformal representation.

Two surfaces are *applicable* or *developable* upon each other if the corresponding infinitely small triangles are *equal in all respects*. This requires that corresponding arc elements shall be everywhere equal, namely, that u_1 and v_1 shall be such functions of u and v as to transform the first member of the equation

$$E_1du_1^2 + 2F_1du_1dv_1 + G_1dv_1^2 = Edu^2 + 2Fdu\,dv + Gdv^2$$

into the second member. The letters with subscripts indicate the elements of the second surface. In general, this transformation cannot be made, and hence two arbitrarily given surfaces are, in general, not developed upon each other. It is obvious that all surfaces derived from a given surface by bending without stretching (see 8) are applicable upon each other. Hence the parameters of any one of them are expressable in the parameters of the original surface. All the surfaces may, accordingly, be assumed definite in the same parameters u, v, whence it follows that the fundamental magnitudes E, F, G will be identically the same for the entire series of surfaces. The three magnitudes E, F, G and all functions formed from them and their partial derivatives are invariants of bending. Some important conclusions can immediately be drawn from these statements. We observe that the left-hand member of equation (γ) is the Gauss measure of curvature and that the right-hand member is a function of E, F, G alone. We conclude that the Gauss curvature does not change in any deformation of a surface by bending. One notes also that equation (ρ) depends only on E, F, G, whence the theorem that a geodesic curve remains a geodesic in the deformation by bending.

As earth-dwellers the most interesting depiction to us is that of a sphere upon a plane. The sphere is not developable upon a plane and, therefore, any depiction is bound to be a distorted image of the original. A conformal representation will at least preserve angles, and the picture and original will be similar in the corresponding infinitely small parts. The two best-known examples of a conformal representation are the stereographic projection (Hipparchus, Ptolemy) and the projection of Mercator. Expressing the sphere of radius one in thermal parameters u_1, v_1:

$$=x\frac{2u_1}{u_1^2+v_1^2+1}, y=\frac{2v_1}{u_1^2+v_1^2+1}, z=\frac{u_1^2+v_1^2-1}{u_1^2+v_1^2+1},$$

and a plane in thermal parameters u, v: $x = u$, $y = v$; the stereographic projection is furnished by the relations $u + iv = u_1 + iv_1$, $u - iv = u_1 - iv_1$, or simply $u = u_1$, $v = v_1$. For the Mercator correspondence one sets up the relations $u_1 + iv_1 = e^{u+iv}$, $u_1 - iv_1 = e^{u-iv}$, or $u_1 = e^u \cos v$, $v_1 = e_u \sin v$. In the stereographic projection the circles of the sphere are represented by circles (or straight lines) in the plane; in the Mercator map the meridians and parallels of latitude appear in the plane as a system of orthogonally intersecting right lines.

SPECIAL SURFACES.

16. Ruled Surfaces.—The continuous motion of a straight line through a simple infinity of position generates a *ruled surface*. When the consecutive generators intersect, that is, when the generating line is always tangent to one and the same space curve, the surface is a *developable surface*. In the contrary case the surface is called a *skew surface*. The *director cone* of the ruled surface is formed by drawing through an arbitrary point of space lines parallel to the generators of the ruled surface. The equations of the most general ruled surface are

$$x = a_1 + \beta_1 u,\ y = a_2 + \beta_2 u,\ z = a_3 + \beta_3 u,$$

where a_1, a_2, a_3; β_1, β_2, β_3 are functions of v alone. The curves $v =$ constant are the right-line generators; the curves $u =$ constant are trajectories of the generators. The trajectory $u = 0$ is sometimes called the director curve. The important elements are: (1) The angle $d\phi$ between two consecutive generators g and g_1; (2) the shortest distance $d\kappa$ between g and g_1; (3) the value of u corresponding to the point, called central point, where the shortest distance meets g. Putting for brevity

$$B_1 = \beta_2 d\beta_3 - \beta_3 d\beta_2,\ B_2 = \beta_3 d\beta_1 - \beta_1 d\beta_3,$$
$$B_3 = \beta_1 d\beta_2 - \beta_2 d\beta_1,$$

the values are

$$d\phi = \frac{\sqrt{B_1^2 + B_2^2 + B_3^2}}{\beta_1^2 + \beta_2^2 + \beta_3^2},$$

$$d\kappa = \frac{\begin{vmatrix} \beta_1 & \beta_2 & \beta_3 \\ d\beta_1 & d\beta_2 & d\beta_3 \\ da_1 & da_2 & da_3 \end{vmatrix}}{\sqrt{B_1^2 + B_2^2 + B_3^2}},\quad u = \frac{\begin{vmatrix} B_1 & B_2 & B_3 \\ \beta_1 & \beta_2 & \beta_3 \\ da_1 & da_2 & da_3 \end{vmatrix}}{\sqrt{B_1^2 + B_2^2 + B_3^2}}.$$

The locus of the central points of the generators is a curve called the *line of striction.* Its equation is the third of the group above. For a developable surface $d\kappa = 0$. The surface is cylindrical if $B_1 = B_2 = B_3 = 0$. The tangent plane to a skew surface at a point contains the generator through the point, and the plane rotates about the line as the point of contact moves on the line. The normals of the surface along a generator form a hyperbolic paraboloid. A ruled surface may undergo a deformation by bending so as to remain a ruled surface. The developable surfaces are so named because they are developable upon a plane. Their linear element ds^2 admits of being thrown into the form of the ds^2 of the plane.

17. Surfaces of Constant Gauss Curvature.—These surfaces are of three kinds: (1) *Surfaces of constant positive curvature* for which K or $\frac{1}{R_1R_2}$ is positive and constant at every point. The sphere is the type of this class. (2) *Surfaces of zero curvature* for which $K = 0$ at all points. These are the developable surfaces (see 16) of which the plane is the type. (3) *Surfaces of constant negative curvature,* $K < 0$, of which the pseudosphere is the type. The pseudosphere is the surface generated by rotating a tractrix about its asymptote. Minding showed ('Crelle's Journal für Mathematik, 19, 1839') that all surfaces of the same constant curvature are developable upon each other, and in ∞^3 of ways. The geometry of figures on a surface of constant positive curvature may, therefore, be studied on a sphere; that of developable surface on a plane; and, finally, the geometry of surfaces of constant negative curvature is identical with that of the pseudosphere. All surfaces of constant negative curvature are called *pseudospherical surfaces.* In employing a geodesic polar system of reference (see 14) the ds^2 of pseudospherical surfaces with measure of curvature $-\frac{1}{R^2}$ takes the form $ds^2 = du^2 + R^2 \sin\frac{u}{R}dv^2$. A characteristic distinction between the geometries of the three kinds of surfaces of constant curvature is indicated by the number of geodesics that may be drawn through a point parallel to a given geodesic. On a pseudospherical surface two parallels may be drawn; on a developable surface only one parallel; on the surface of positive curvature, none.

18. Minimal Surfaces.— They are defined to be the surfaces of mean curvature zero, $H =$ (see 12). At every point of such a surface $R_1 = -R_2$. Historically the theory of these surfaces had its origin in Lagrange's investigation of the surface of minimum area with prescribed boundary curve. It was ascertained that for such a surface $R_1 = -R_2$, but the converse statement does not always hold without limitations. Integrations of the differential equation of minimal surfaces were given by Legendre, Monge and Enneper. We give here the equations as found by Weierstrass:

$$x = \tfrac{1}{2}\int(1-u^2)F(u)du + \tfrac{1}{2}\int(1-v^2)F_1(v)dv,$$
$$y = \frac{i}{2}\int(1+u^2)F(u)du - \frac{i}{2}\int(1+v^2)F_1(v)dv,$$
$$z = \int uF(u)du + \int vF_1(v)dv.$$

F and F_1 are conjugate functions of the conjugate complex variables u and v. All minimal surfaces are contained in these formulas. When the function F is algebraic the surface is algebraic, and conversely. A minimal surface can be deformed by bending so as to remain a minimal surface. For this it is necessary and sufficient that one replace $F(u)$ and $F_1(v)$ by $e^{ai}F(u)$ and $e^{-ai}F_1(v)$ respectively. All the surfaces corresponding to values of a (real constants) are developable upon each other as having the same ds^2. The only ruled minimal surface is the ordinary helicoidal surface with director plane. The only minimal surface of rotation is the catenoid, i.e., the surface generated by rotating a catenary about its base. These two surfaces are developable upon each other. The minimal surface is the only surface (aside from the sphere) whose spherical representation is conformal (see 12 and 15). For particulars as to these surfaces consult Schwarz, 'Gesammelte Mathematische Abhandlungen' (Vol. I, 1890); Darboux, 'Leçons sur la Theorie Générale des Surfaces' Vol. I, 1887).

19. Concluding Remarks.—In addition to the special surfaces here described may be noted the *surface of centres,* i.e., the locus of the centres of curvature of a given surface. It consists of two sheets S_1 and S_2 corresponding to the two centres of curvature at every point. Also may be noted the *W-surfaces* or *Weingarten surfaces,* in which R_1 and R_2 are functionally related. A functional relation, $f(R_1, R_2) = 0$, defines an infinity of surfaces. In passing to the surface of centres of each individual of such a group, Weingarten showed that all the sheets S_1 are developable upon each other and upon the same surface of rotation. The same theorem holds of course for the sheets S_2. Surfaces of constant curvature, and minimal surfaces are special W-surfaces. Finally, there are certain analytical expressions constructed in the fundamental magnitudes, some arbitrary functions, and derivatives of the functions, which have the same value whatever the parameters employed. In other words they are quantities invariant with respect to a change of parameters. When the arbitrary functions are present they are called *differential parameters.* When the arbitrary functions are not present they are called *differential invariants.* Manifestly these magnitudes are connected with those geometrical properties that are essentially independent of the particular system of parameter reference. For example, Gauss curvature $\frac{1}{R_1R_2}$ is obviously an invariant.

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JAMES MACLAY,
Professor of Mathematics, Columbia University.

SURGEON IN THE ARMY AND NAVY OF THE UNITED STATES. The history of the connection of a regular staff of surgeons to the army dates back to the siege of Boston in 1775. At that time the Second Provincial Congress of Massachusetts Bay was in session and on 8 May 1775 appointed a committee «to examine such persons as are or may be recommended for surgeons with the army now forming in this colony.» Of the 16 candidates examined only six were rejected. On 21 July 1775 Washington urged in a letter to the Colonial Congress that a «Hospital Department» be established, and on 27 July this department was created, having a director-general, chief physician and 20 surgeon's mates. In April 1776 Congress passed an act that the board of surgeons be increased «not exceeding one surgeon and five mates to every 5,000 men, to be reduced when the army is reduced.» Between 1784-89 no medical department was officially recognized by the government, but was in the latter year recognized and remained the same until 1821, when it took the form which it retained with no decided change until 1908 when the titles of all medical officers, excepting the surgeon-general of the army, became the military rank, major, captain, etc., followed by the words, Medical Corps, U. S. A. Applicants for the medical corps must be between 22 and 30 years of age, be citizens of the United States and graduates of a reputable medical school and have had at least one year's hospital training. After successful examination they are commissioned as first lieutenants. The Act of 1908 also established the Medical Reserve Corps, the members of which rank as first lieutenants and are appointed by the President after an examination. During the Civil War and the Spanish-American War the corps was increased to meet the emergencies, but on the cessation of hostilities was again placed upon a peace footing. Consult Lamphere, 'United States Government' (Philadelphia 1880); Farrow, 'Military Encyclopedia' (New York 1885); Hamersley, 'Army and Navy Register' (New York 1888) and other War and Navy Department records. See UNITED STATES, ARMY OF THE; UNITED STATES, NAVY OF THE.

SURGEON-FISH, a fish of the family *Teuthidæ*, allied to the butterfly-fishes (q.v.) and distinguished by the presence of one or more erectile lancet-like spines on each side of the root of the tail which may inflict an ugly wound. Some 80 species are known, mostly of the genus *Teuthis*, scattered through the warm seas of the world and variously known as doctor-fish, lancet-fish, tangs and among the Spanish-speaking fishermen of the West Indies as barberos and médicos. All are oblong, compressed, brownish or bluish fishes from 6 to 12 inches long, with narrow protruding incisor-like teeth. Several are good food, especially the ocean surgeon-fish (*T. bahianus*) found throughout the West Indies, and the blue tang (*T. cæruleus*), found near Porto Rico.

SURGERY, History of General. The history of medicine, fascinating at all times, is most valuable to the surgeon when applied to the subject of general surgery. At the present time there is much in the literature of medicine that is very instructive and it becomes more and more so as we are put in possession of facts pertaining to prehistoric man and of those presented in the study of manuscripts antedating the Christian era.

Skulls of the prehistoric period have been discovered in caves and dwelling-places which show undoubted evidence that trephining had been performed on them and that healing of the bone had later taken place. The examination of these specimens is exceedingly interesting. Again, as we study the periods between this age and the beginning of the Christian era we note a great deal that leads to the conviction that surgery was understood in those times. The early embalmers, in their familiarity with the human body, must have acquired some knowledge of surgery, and this as far back as 1700 B.C.

While medicine as a profession was confined to the duties of the priest, surgery suffered, and was more and more neglected. Historians of that time have just reason to condemn Egyptian surgery. There are some very excellent books appearing at the present time giving a full description of what little was known, bestowing full credit upon those who practised surgery, or advocated it, and who were making some progress in that branch of medicine. The Egyptians were proud and fond of their work as scribes or writers, their learning in that direction leading them to advise their sons to take up what was then known on the subject of medicine; but very little seems to have been developed in the way of clinical observation, or, more particularly, in surgical procedure.

In the study of medicine by the Hindu one cannot but note that in their writings there is plain evidence that surgery had reached an advanced stage. «Surgery,» says their great Susruta, «is the first and highest division of the healing art, least liable to fallacy, pure in itself, perpetual in its applicability, the worthy produce of heaven, the sure source of fame on earth.» He also makes the very excellent observation that «he who knows but one branch of his art is like a bird with one wing.» This writer was a very careful observer and beyond doubt did much to advance the art of surgery centuries before the birth of Christ. Some of the Hindu works and operations are yet spoken of by modern writers. They knew how to perform successfully the operation of developing a new nose by flaps taken from the forehead and were familiar with like procedures. The surgery of ancient India is worthy our most thorough and careful investigation. Great interest is being manifested in its study and there can be no doubt that good will result from the recent organization of the Charaka Club in

New York. This body of investigators bids fair to give us papers of great value in the elucidation of that period when Hindu surgery developed — and, it may be said, ceased. Why it disappeared so mysteriously has never been shown.

Through the study of manuscripts of succeeding centuries, and of other records of different peoples, one is greatly impressed with the difficult operations performed, now and then, by some predominating man, who, perhaps having more knowledge of the anatomy of the human body, and being somewhat bolder than his fellows, would perform an operation, leaving a report of possible success. Then for centuries this work would be forgotten, then revived, perhaps modified. Possibly to the operator it was a new operation (since he was not aware that it had been performed previously), yet to be developed into a line of work that was to lead to greater success. Thus we see reported very important advances in the line of surgical procedure from our earliest knowledge on.

The early Greek knowledge of surgery is not so apparent or abundant as that of later periods, yet Homeric medicine gives endorsement to the fact that there were surgeons capable of rendering aid in emergencies, such as the removal of foreign substances from the body, and who were able to control bleeding by the application of what were evidently understood to be drugs possessing some styptic power and to bind up and dress wounds. Even fractures and dislocations were treated. In time of war these men were looked upon with reverence and the aid they were expected to render was highly valued. Of their real work there is little known before the Trojan War. The most observing student of cases in antiquity was Hippocrates (q.v.) born 460 B.C. He wrote on the treatment of articulations, luxations, fractures and also on the subject of the use of instruments, but his knowledge of anatomy must have been very meagre. The Greeks had great respect for their dead, which prevented dissection of the human body. They knew nothing of physiology and, therefore, anatomical structures, such as arteries, veins, nerves, tendons, ligaments and membranes were hopelessly confused. Hippocrates gave classifications not unlike those of the present day, «internal medicine» and «external or surgical medicine,» which were convenient, but not philosophical. The period of his life marked the transition from mythology to history. His doctrine and clinical observations were received with great respect. He advanced the science and art of surgery, but only a little later ignorance again reigned in the school which he made celebrated.

Erasistratus (about 300 B.C.) was a close observer as an anatomist and made use of his knowledge of the valves of the heart. He discovered the lymph vessels, described the epiglottis, successfully removed the spleen and performed other remarkable operations.

Aretæus was one of the most brilliant men of the second century before the Christian era. He recognized surgical affections of the brain and described the Syriac or Egyptian ulcer, tetanus and anal fistula.

Galen (q.v.), who died about 201 A.D., must have had considerable knowledge of anatomy. History indicates that he was a vivisector, and to him is due a clear classification of the muscles, which is followed at the present day, as the «flexors and extensors.» He came very near discovering the circulation of the blood, and divided the body into the «cranial, thoracic and abdominal cavities,» whose proper viscera and envelopes he described. This was during a period when encouragement was given to the study of anatomy. The works of one Oribasius (q.v.), who died about 400, were based on the writings of those who had preceded him, but had a distinct importance of their own. He showed much originality in the treatment of hydrocephalus, advised paracentesis of thorax and abdomen, removal of vesical calculi, treatment of aneurism, excision of hypertrophied mammæ in men, etc. Antyllus who flourished about this period was one of the most distinguished and original surgeons of antiquity. He was the first to describe the extraction of small cataracts and is perhaps best known to the surgical world of to-day by his exceedingly bold plan of opening aneurisms, so successfully imitated by the late James Symes.

It is to be remembered that during the Greek period Galen and his followers dissected animals and occasionally a corpse on the field of battle.

In the 6th and 7th centuries the Arabians gave more encouragement to dissection and demonstrated that surgery required a knowledge of anatomy. One of the most celebrated Arabian physicians was Rhazes (q.v.), who died about 932. He compiled from all authors some 37 books on medicine and surgery.

Albucasis (936–1013) in one of his writings gives a most detailed account of necessary instruments and in speaking of their proper use and application to surgery, he emphasizes the fact that surgeons should be versed in the science of anatomy.

In visiting the various museums in Europe at the present time, especially Naples, one is greatly impressed with the variety of ancient surgical instruments that have been recovered from the ruins of Pompeii and other former surgical centres.

Avenzoar (q.v.), who died about 1169, wrote one of the most remarkable treatises on renal diseases, especially in reference to the treatment of calculus and further surgical intervention.

From the 9th to the 13th century the Jews and the Christian clergy shared the honors of the healing art, and during this time references are not infrequently made to the work of the barber-surgeon (see BARBER). Lithotomy (q.v.) seems to have been developed in this period and it is noted (1022) that Henry II, Holy Roman emperor, was cut for stone by Saint Benedict himself.

In the 13th century Rolger of Palermo was evidently one of the most distinguished pioneers in modern surgery. He was the first to use the term «seton.» His pupil, Roland, wrote a treatise on surgery, which became very famous and was mentioned by Guy de Chauliac, «restorer of French surgery in the 14th century.» The latter was probably one of the most famous surgeons of that time. He opened the abdomen for dropsy and operated for the radical cure of hernia and for cataract.

The history of the school of Salerno in the 13th century indicates that practitioners of surgery had to devote a certain time to the study of anatomy, were obliged to pass an examination by the faculty of the university and were licensed by the royal hands. Surgeons recognized the importance of nausea, vomiting and hemorrhage from the ears, in injuries to the head. They used the trephine (q.v.) in treating fractures of the skull and treated hernia cerebri by pressure and caustics. Ligatures were used in wounds of the carotid arteries and jugular veins. The surgeons also treated wounds of the abdomen. Lithotomy was described with care and compound fractures were treated with splints.

The first important work on minor surgery appeared during the 14th century. It was written by Lanfranc, but although it grew into a second and larger treatise, surgery soon after this began to decline. The barber-surgeons of this time seemingly commanded considerable attention, although it is evident that the importance of this body of men has been greatly exaggerated.

From the 15th century through the 19th surgery developed more and more as a science. In England, Thomas Linacre of Canterbury (1460–1524) was one of the earliest writers. Jerome Fabricius (1537–1619) was also a noted writer and authority on the practice of surgery during this period. Benivieni during the same period was, according to Malgaigne, the first to impress upon the profession the importance of searching in the cadaver for the concealed cause of disease. His observations on gall-stones and conveyance of syphilis from the mother to the fœtus were original.

Notwithstanding the progress in surgical science during the 15th and 16th centuries, the practice of surgery was largely abandoned to a class of ignorant barbers and bone-setters. Most of these operators traveled from city to city, individual practitioners limiting themselves to the operation for stone or for hernia. This condition of affairs, together with the prejudice against dissection, was most unfavorable for the profession of surgery.

France at this time presented the only special college for the instruction of surgeons. To the 16th century belongs the career of that most wonderful surgeon, Ambroise Paré. He was an original thinker, had the courage of his convictions and did away with the use of the cautery and boiling oil in amputations, using ligatures to control hemorrhage, the latter being the most important advance until the introduction of ether in 1846 (see ANÆSTHETICS). At the beginning of the 17th century surgery reached a higher social and intellectual plane than it had heretofore occupied. Amphitheatres for dissection developed in many European cities, together with hospitals and dispensaries in connection with the various schools. The term «inflammation» was then introduced and from that time until the present day has been a subject for continuous investigation. From this period may be dated the beginning of consultation work between expert practitioners; and clinical teaching and the presentation of surgical cases then advanced their claims. Surgical history from Valsalva on presents the names of many who became eminent operators, and in their writings did much to advance the art of surgery. Notably was this so among the Italians, who in their plastic surgery developed the Italian method for construction of a new nose.

In France, Morel (1674) invented the tourniquet, Denis performed the first transfusion of blood in man and other French surgeons became very expert in the operation for lithotomy. Mareschal (1658–1736) had a record of eight lithotomies performed in half an hour. He was one of the founders of the French Academy of Surgery.

In Holland, Rau (1658–1719) taught practical surgery upon the cadaver.

Wiseman (1625–86) was the first to develop English surgery. He was also the first to do external urethrotomy for relief of stricture. At this time in France alone was instruction in surgery well regulated, as it was the only country which possessed a proper surgical college.

In the 18th century hospitals began to multiply in Germany, benefiting general surgery to a great extent. Brasdor (1721–76) developed the method of distal ligation of aneurisms, while Sabatier (1732–1811) wrote a treatise on operations and recommended resection of the head of the humerus. DeSault and Chopart did much in developing operative surgery. In Italy Scarpa (1752–1832) advanced our knowledge of hernia and aneurisms. Spanish surgeons did little to improve the science and art of surgery. In England, Cheselden (1688–1752) did much in advancing the knowledge of pathology and general surgery. White, of Manchester, devised a method of reducing dislocations of the humerus with the foot in the axilla. A well-defined operation for excision of the joints was also first practised in England. The investigation of pathology and diagnosis in France at this time had much to do in the 19th century in developing the «new Vienna School.» Percival Pott (q.v.) did much in elaborating and classifying diseases of the joints and especially spinal diseases. John Hunter (q.v.) was the most famous English surgeon of his day. He belonged to a family which in many ways assisted the development of pathological anatomy and surgical technique. At the close of the 18th century, Benjamin Bell was the first to make use of drainage by means of tubes of lead or silver. In France, Bichat (q.v.), although not generally so understood, became a forceful lecturer on surgery and did much to bring hospital-gangrene under observation and control. The Dutch during the 18th century developed some eminent surgeons, and it is interesting to note how dextrous they became in the use of instruments. At the same time their knowledge of anatomy enabled them to present some very able papers on the subjects of hernia and dislocation. Sandifort, of Leyden, first described a downward dislocation of the femur.

In reference to the surgery of our own country in the 18th century, one of the most interesting works, which was of great service to American surgeons during the Revolution, was that of John Jones, 'Plain, Practically Precise Remarks on the Treatment of Wounds and Fractures.'

The 19th century witnessed great advances and from 1838 was one continuous chapter of investigation toward the development of the parasitic or germ theory. Of all the many names associated with this immense work, one can refer to but few: Pasteur, Klebs, Koch, Lister, Tyndall (qq.v.) and others, in their development of bacteriology, have done more to advance the principles of technique in surgical operations and have placed the art and science of surgery upon a more lasting foundation, than any of their predecessors.

The first half of the 19th century was a period of great success for the French surgeons. The English surgeons, in their superior knowledge of gross anatomy, also made great advances in their diagnosis and surgical treatment. This century became noted as the period during which general surgery developed more into an exact science. Its writers did much to eradicate erroneous ideas and to end the transmission of meaningless sentences from one textbook to another. The introduction of anæsthesia in 1846 enabled some of the bolder men to perform operations heretofore deemed quite impossible; yet the ratio of mortality continued high and it was not until the dawn of antisepsis, more particularly the period of true asepsis, that general surgery advanced so rapidly. The death-rate in major operations, in many instances, was in a short time reduced from 66 to 6 per cent, and this ratio was soon applied to all departments of surgical work. As technique became more perfect, all manner of operations were suggested and carried out with great success. Hence to-day there is no part of the human body that the surgeon is unable to reach for the relief of injuries or pathological conditions.

In operative surgery much help has been received from the use of cocaine, eucaine, suprarenal extract, ethyl chloride and other preparations for local and spinal anæsthesia. Bacteriology has taught the surgeon the cause of inflammation, suppuration of wounds and sepsis. New hospitals, aseptic operating-rooms and furniture, thorough sterilization of instruments, hands and the field of operation and cleanliness of person, together with the wearing of rubber gloves, coupled with aseptic dressings, have enabled the surgeon to perform operations unknown before the last decade of the 19th century, reducing mortality to a much lower figure. An important factor which has been of much aid to general surgery is the art of nursing, first recognized in 1840. Too much credit cannot be given to the training schools of to-day for their development of trained nurses who have aided so much in the care of surgical cases.

During the 19th century the microscope became of more and more value. The anthrax bacillus was classified in 1850 and then followed classification of the various micro-organisms known to-day. Koch's identification of the tubercle-bacillus has aided the general surgeon as much in the treatment of osseous tuberculosis as it has the physician in tuberculosis in other parts of the body.

For the past two decades general surgery has presented a mass of material, largely experimental, and much of it bacteriological and pathological. The latter has assumed a better position because of some real practical discoveries, but, during that time there has been a large sifting out of much that was thought of great value, experience, however, demonstrating to the contrary. Let us consider the treatment of fractures. The various methods of plating and suturing, by means of silver wire, have had very strong advocates, yet the use of splints, extension and position have retained their well-recognized effectiveness. There would seem to be a concensus of opinion that when the X-ray shows the fracture has been reduced and the parts brought into a fairly normal position, these cases do fairly well without operative intervention; however, when the positions are faulty, and, even though an anæsthetic is employed, reduction cannot be accomplished satisfactorily, there can be little doubt that they do very much better and more perfect results obtained, by operative proceure. It is now becoming recognized the fractures of the clavicle and other irregular bones demand operative intervention, by employment of plates and like methods.

The knowledge of the anatomical relations of the various joints, especially that of the hip and shoulder, with the aid of X-ray, manipulation, becomes more perfect and more reliable in results.

In dislocations the X-ray has continued to demand greater employment because of its worth.

In the past 10 years it is pleasing to observe that the methods of scientific X-ray work have become very much more extensive and precise; that with the ability to use the X-ray apparatus, in examinations of the head, thorax, abdomen, pelvis and extremities, greater precision has been reached and the results much more reliable and satisfactory; that in the understanding of the location of foreign bodies, much has been accomplished in reading the shadows correctly.

It is in the diagnosis of fractures and dislocations that there has been a steady, continuous improvement. This observation becomes very appropriate when referring to lesions of the spinal column and surgery of the spinal cord.

This knowledge also applies to the better understanding of pathological conditions, especially within the abdomen and the location of stone in the kidney and bladder; however, this must be said, that in the past few years physicians, surgeons and specialists have come to recognize the Roentgenographer as the one alone who can interpret the radiograms and make it clear to the surgeon who is responsible for the case, when an operation is undertaken. In the past it has been too much the custom for the attending medical man to translate the X-ray picture himself and many errors have occurred in that way. This is especially true in reduction of dislocations.

Operations upon the head and teeth, due to the study of X-ray work, have become much better understood, the classifications calling for such procedure much more reliable and showing more and more perfect results.

Compartively recently pathology has demonstrated that septic teeth have much to do with the development of many surgical lesions, in the past overlooked, and, which, like the tonsils, frequently become the bed for the introduction of pathological micro-organisms into the system.

There has been added to the history of general surgery a very interesting chapter on the treatment of phlegmons and inflammatory, septic conditions, by employment of the method known as passive hyperæmia. When promptly and effectively made use of it is of great value in cutting short infective invasion of the lymphatic system, especially when applied to the extremities.

The treatment of malignant disease by means of serums, especially Coley's fluid, maintains a semi-successful position, but, considering the length of time it has been employed, it would seem as though it ought to have offered more encouraging results.

The same applies to X-ray treatment, advocated by some so earnestly in its use previous to, and after, an operation for relief of malignant troubles, yet not establishing itself as a positive curative agent.

The range of general surgery is becoming so great, the multiplicity of theories and papers presented such that one grasps with satisfaction any contribution and conclusion, regarding the methods of diagnosis and treatment that may be said to be final and the results such as to command the confidence and respect of the operator.

The history of modern methods, regarding general surgery, in pathology and diagnosis, through bacteriological, laboratory work, is wonderfully encouraging, but much more time is required than was made use of by the surgeons of a somewhat recent and later date, in their examination of cases.

The thorough study of the blood, bacteriologically and otherwise, the vaccines, are all to be considered in the present history of surgery and proving elements of great importance. This applies to all modern surgery, reaching all points that have developed through research work and of great use in the study of general surgery to-day.

In the study of the history of general surgery, the many papers that are presented in our medical journals, also in our textbooks, from year to year, it is to be observed that advances are being made in the methods of diagnosis and proper treatment. There is this criticism: That too often exploitation of supposed new discoveries, in their proper relation, have failed to maintain the expected high standard of success, for instance, in appendicostomy. At first suggestions for this operation met with a great deal of encouragement in the hope that, as the appendix was permanently fixed in the incision, it could be made the source of successful treatment of pathological changes within the large intestine; however, it does not seem to have found approval to the extent of many cases appearing on record, or employed so extensively as at one time thought possible.

Also, while there have apparently been a few excellent results, yet Edebohl's suggestive treatment of nephritis, by decapsulation of the kidney, does not seem to have sustained the endorsement of the pathologist or the operating surgeon.

In the changes and successes in diagnosis and treatment, during the past decade or two, great progress is to be observed in comparing one period with another — one method with another. That of which so much was expected too often proves valueless, while that which seemed of lesser importance proving of great value, on trial.

In civil life the advances made in surgery of the head, face, neck and thorax, the mediastinal space, the heart, of the lungs and pleura, indicate the calm, steady progress that is now to be observed in all larger hospitals.

Especially does this apply to stab wounds of the heart, to the drainage of abscesses within the pericardium, also in operations upon the lungs and treatment of the pleura for various surgical conditions.

The recent acquisition of the pathology of the thyroid and parathyroids has resulted in the understanding of goitre, far ahead of anything that has ever taken place in the past. The function of these glands, the classification of symptoms and of the pathological condition, has enabled the surgeon to do his work in a more scientific manner and the results much more favorable. The better understanding of the term exophthalmic goitre is exceedingly pleasing in every respect.

In abdominal surgery it is no longer necessary to make use of theories, for practical facts are such that, for instance, in surgery of the liver, gall-bladder, pancreas, gall ducts, the pancreatic ducts, there is now a fixed line of treatment, and not to be deviated from very much. This is becoming more and more positive, and also applies equally well to the appendix.

The surgical treatment of gastric and duodenal ulcer is one of the finest demonstrations of surgery being made more of as an exact science than internal medicine has yet attained.

Injuries and diseases of the pancreas and spleen illustrate much of the advance made in the field of diagnosis and treatment.

The abdominal cavity has come under such thorough observation that the right side can no longer hold its exclusive position regarding operative intervention.

There is no part of this one classification of the human body, and in which Galen was so correct, that is entirely free from possible invasion.

In the past two decades much has been added to our knowledge of intestinal surgery and methods of treatment have reached a more conclusive line of operative procedure.

In civil life no more brilliant results can be shown in any of the various departments of surgery than the treatment of multiple gunshot wounds and ruptures of the intestines and other organs within the abdominal cavity.

This applies particularly to hernia — rupture — and especially for relief of gangrene of the intestine. To the surgeon of many years practice, it is particularly striking to note how few cases we now come in contact with of delayed strangulated hernia, in which we have the complication of gangrene of the bowel. The prompt recognition for early operation in such cases has largely eliminated this catastrophe. Our pathological knowledge is much more clear, also the willingness of the patients to have an early operation, and not trust to mechanical supports. These cases, treated, as they often are, comfortably and palliatively by the application of trusses, still continue to present an excellent history in the good results of operative intervention. We see a gradually increased willingness, in fact patients often seek an operation, the result being so thoroughly satisfactory. All of this applies as well to children as adults.

In the treatment of conditions within the abdominal cavity a greater concensus and uniformity of opinion has been reached than in some other surgical channels.

Perhaps we may say there is yet a lack of uniformity in doing the operation of intestinal anastomosis.

Excision of the large intestines seems to have reached the peak of operative intervention, and present results are being studied with great care, regarding curative results in this class of surgery.

Surgery of the appendix gives a very extensive history regarding what has been written in the past, and, now, regarding diagnosis and treatment, becoming very concise. The general practitioner of to-day is more alert than ever in the recognition of early symptoms and prompt surgical procedure. When these methods are yet more thoroughly considered and carried out, the appendix, from the medical and surgical standpoint, will present a mortality much less than exists at present, though this is exceedingly small.

The history of operations done upon the bladder, for various pathological conditions, is a very impressive one. Decided advances have been made in this direction, and the same can be said of the prostate gland, while surgery of the kidney has reached a point of great precision, the same also to be said regarding the ureters.

In all that pertains to the surgery of the abdominal cavity, much has been accomplished through the study of the Trendelenberg and other positions for the patient during the time of operations, especially upon the kidney or gall-bladder and in pelvic work. Much of this also applies to the treatment of the patient after an operation, particularly in suppurative, septic appendicitis, as has so well been brought out by the writings of the late Dr. Fowler.

In the advances made within the abdominal cavity the searching out of every pathological condition, no organ or tissue being overlooked, is one of the most impressive to be noted in the history of general surgery.

Gall-stones have a way of giving a great variety of symptoms, the same applying to cases of appendicitis, and which, perhaps, has brought out many valuable conclusions.

In operating upon either of these organs and not finding a pathological condition that will accord with the symptoms, it is admitted by most surgeons that a more thorough examination is called for, and in some other unsuspected organ may be found the source of the symptoms, relief being afforded only by doing the operation called for in that direction.

Since the last edition of the Encyclopedia Americana much has occurred in the history of general surgery, regarding surgical procedure, to make clearer new fields of observation, and which applies especially to the abdomen and its contents.

The abdomen has claimed much of the attention of the general surgeon. It has not been possible for the specialist to control this line of work. With our increased knowledge of pathological changes within this cavity, and with the aid afforded the operator through the advances made by the assistance of the experienced radiographer, who is able to interpret radiograms correctly, the success has been so great that patients, or their friends, have little hesitation in entering a hospital, or going to the operating table, when the necessity is made apparent to them. Hence in the building of the many smaller hospitals the past few years, local surgeons have developed an experience that permits of doing many operations deemed impossible for them to perform a few years ago.

In the past two decades much progress has been made in surgery of the bones; in the conservation of limbs and joints; in the better understanding of pathological conditions and especially does this apply to cases of malignant and tubercular troubles.

Surgical lesions of the circulatory system have received much attention, and surgeons have had occasion to discuss the subject of idiopathic aneurisms. Operative surgery in the near past has not met with so many of these cases, and the condition is believed to be due to the more successful treatment of syphilis, this being one of the chief factors in development of this lesion.

The subject of inflammation of the veins — phlebitis — has commanded careful investigation in our laboratories, it so often being the factor in connection with sudden death following an important operation. To relieve the blood clot that forms in the vessel, then suddenly separates, enters the circulation, plugging the heart valves and causing sudden death, calls for surgical intervention, when it can be recognized as being present in the large veins of the extremities.

It is also to be observed that a less number of cases of stone in the bladder are presented, due to the better understanding of calculi originating in the kidney, and this condition corrected by the study of diet, the drinking of properly selected mineral waters or the careful use of plain sterile waters. Here diet has much to do in lessening the development of many surgical lesions.

The medico-legal side of the responsibility of the surgeon has been pretty thoroughly covered the past few years in the history of malpractice suits for foreign bodies left in the abdominal cavity, with the result that the operator, the hospital or nurse share somewhat alike the responsibility, and must give evidence of having exercised every precaution possible to avoid such occurrences. Especially is it the duty of the surgeon to have it well understood with the one nearest in relationship to the patient regarding the extent of an operation. If, in the midst of it, it is found necessary to do more than was explained, the operator must communicate with the responsible person regarding the condition present that requires more serious, additional procedure. This is one reason why every cautious surgeon desires some person near at hand to inform them, should complications unexpectedly arise. Our

British surgeons have had some unpleasant experiences in this direction.

Regarding the anæsthetic in use by the general surgeon, it may be said that sulphuric ether is undoubtedly employed to a greater extent than either one of the other anæsthetics. Chloroform is believed to be advisable in the short operations, and in those upon children, while for those only requiring a few moments the nitrous oxide or ethyl chloride are of great service.

ALBERT VANDER VEER, M.D.,
Professor of Anatomy, 1869–74. *Professor of Surgery,* 1876–1915, *Albany Medical College.*

SURGERY IN AMERICA. If at any time one should purpose writing a history of the progress of surgery on the American continent he must not fail to remember that in the earlier part of its history America was absolutely dependent on Europe, and could not be expected to reflect anything better in the direction of science than that which it received from its mother-country, Therefore, the most suitable introduction that could be made for the history of surgery on this continent would be a review of the status of the 17th century in Europe. Very prominent were two or three philosophical systems which had been handed down from previous thinkers. The skepticism of Montaigne, with its final reduction by Bayle to universal doubt or universal credulity, and the supernatural or mystic philosophy of Böhme, sometimes spoken of as the cabalistic or theosophistic, which includes the discoveries of Pascal and Malebranche, were the prevailing systems or methods of thought. In the meantime Bacon had lived and died (1626), who, though he laid great stress on gunpowder and the compass, had but little respect for the discoveries of Copernicus. Zoology and botany were fairly well advanced and had been extended by dissection and by classification. Hooke had discovered the cell and had founded the cell-doctrine. Kepler and Galileo had been persecuted and had left their discoveries for others to verify. Newton entered the world some years after the date of the first expedition of the *Mayflower* (1642). Continental Europe had many universities, some of which have been discontinued or merged into others. Numerous academies of science had sprung up in different parts of Europe, and the present British Royal Society was remodeled in 1662 by Charles II. Nevertheless, all kinds of superstition prevailed, alchemy flourished, witchcraft was in full bloom, necromancy was generally practised and the divining rod flourished, and all domestic animals were kept under cover during an eclipse lest they be threatened by dire pestilence of unknown character. In 1628 Harvey had published his work on the circulation of the blood, and in 1608 the microscope had been invented by Lippersheim, although by some its invention is attributed to Jansen in 1620. At all events it was greatly improved by Hooke, who died in 1702. Logarithms were not invented until the American colonies were nearly 100 years old (Napier, 1700); but the weight of air had been established by Toricelli in 1643. Previous systems in medicine were then modified, to be reformed on the modified Paracelsism devised by Van Helmont or the humeral views of Sylvius and Willis. Sydenham appeared upon the scene about the time of the first expedition of the *Mayflower*, and, until his death in 1689, the larger number of English physicians who came over in his day had been more or less under the influence of his teachings.

The 17th century is important in the history of surgery, since superstition and self-satisfaction gradually gave way to the inductive method and improved habits of observation. Even among the Dutch, who settled new colonies in this country, surgery now assumed a dignified position, while among the English, French and Germans it had already attained something of this character. These were still, however, the days of the barber-surgeons, who were not considered gentlemen nor fit to associate with gentlemen, who were, for the greater part, an uneducated and illiterate class. The study of anatomy was still pursued with difficulty, the ban of the Church yet covering those who took part in any operation which was accompanied by the shedding of blood. In such a state were the mother-country, the Netherlands and France, while still worse off was Spain, at the time when the early adventurers or pilgrims from these various countries landed upon our shores and began to make American history.

Colonial History.— The English colonists brought their physicians with them on nearly all of their expeditions. Thus when Jamestown was founded, in 1607, we hear of one Wotten, or Woolton, who came out as surgeon of the London Company, who was even considered a gentleman among the others of the expedition, whether by courtesy or right it is not known. Walter Russel followed in 1608. Even within that first half-century came the need for some definite laws regulating the practice of medicine, since throughout the colonies quackery flourished to a considerable extent. There was at this time little to attract travelers to this country except the spirit of adventure, which the better educated men possessed in minor degree. Many of the earlier physicians of the colonies were church deacons or politicians or both. Thus Samuel Fuller, who came to Plymouth in 1620, preferred to be known as a deacon rather than as doctor, although he practised medicine faithfully and, for his time, well. John Winthrop, Jr., was not only a physician but a statesman. In 1667 he became governor of the New Haven colony, and he must have enjoyed much repute in England since he became one of the founders of the Royal Society. Up to 1692, 134 physicians had been catalogued as practising in the colonies. The first person executed for witchcraft was one Margaret Jones, who was also a physician.

In the New Netherlands, controlled first by the Dutch West India Company, it was provided in their charter that they should procure a «Comforter for the Sick.» The first one of prominence under this provision was Bogaerdet in 1637; later came LaMontaigne, who was both a Huguenot and a physician. Prominent during the middle of the century was one Samuel Megapolensis, who was born in this country and graduated from Harvard in 1657, and then went to Utrecht, where he took his medical degree. He practised in Manhattan both as a physician and preacher. In 1772 a Quaker, George Fox, was traveling with John Jay when the latter was thrown from his horse and had his neck apparently broken. Fox at once instituted a manipulation by which, apparently, the dislocation of the upper vertebræ was reduced and by which Jay was restored to life. This must be one of the earliest cases of this kind on record. When William Penn came to this country he brought with him Dr. Wynne, an accomplished Welshman and probably the most competent man of his profession in America at that time.

The colonies were swept during this century with fierce epidemics of yellow fever, smallpox, scurvy, dysentery and many other diseases, by which the colonists suffered great loss. Those who came over with William Penn numbered about 100, of whom one-third died on the voyage of smallpox. This was perhaps the most terrible scourge of all and was not successfully battled with until Dr. Boylston dared to institute the method of inoculation to which his attention had been called by Mather, who had read of its successful introduction into England from Constantinople by Lady Montague. In this is constituted one of the most interesting episodes in the history of medicine in this country. The Rev. Cotton Mather, distinguished both as a politician and divine, still had this on his mind even after he had lost his interest in the burning of witches. In 1721 he read a paper on Turkish Inoculation written by one Timonius, and became deeply interested in it. He endeavored to interest various young men, especially a Dr. Douglas, in the discovery and in the method. Failing in this he turned to Dr. Boylston, then of Brookline, Mass., who saw the importance of the method and the ripeness of the occasion. As soon as his purpose became understood he was at once denounced in the pulpits and attacked by the multitudes, and had as his only backer the man Mather, who had not yet lost his authority with the clergy. Opposed, then, by his colleagues and by the clergy in general, and the universal rabble, Boylston had the hardihood to inoculate first his own son and two negro servants, and this only six weeks after the first inoculation was done for Lady Montague in London, by Dr. Maitland. But Boylston lived to reap glory and profit from his intrepidity. The controversy which he aroused had subsided in this country when he went to London, where he found it still raging, and where he again aroused a storm, but eventually triumphed. (This method must not be confused with vaccination, but consists of the actual inoculation of the disease by pus or discharge from the lesions of the patient suffering from the real malady. It is practically the same method which had existed for centuries in the Orient).

A great part of the 18th century was spent in warfare between natives and the newcomers to this country. The Indians were almost always active, while the English and French fought more or less continually, the scene of conflict extending from Quebec on the north to the Niagara Frontier on the west and Georgia on the south. In spite of the many opportunities thus afforded for the study of military surgery it does not appear that much was done in the way of improvement of older methods or in new discoveries. The wounded soldier of 1776 had but little better treatment than the wounded pilgrim of 1676. There were a few men of such prominence scattered along the coast line in the early and middle part of the 18th century that they deserve to be mentioned, at least by name. Cadwallader Colden was born in Scotland in 1688, and came to this country in 1707. In 1710 he moved to Philadelphia. Here he wrote some of the first medical papers written in this country, particularly on animal secretion. After some years spent in this country he took up his residence in New York, in 1716. He was during the early part of his life an indefatigable student and attained remarkable popularity in his practice. He held numerous public offices and figured rather as a statesman than a physician. He acquired a large estate up the Hudson and became the intimate friend of Benjamin Franklin, to whom he first suggested the foundation of the American Philosophical Society. He left a large number of writings and correspondence with the most eminent savants all over the world.

As the colonies steadily progressed in wealth and size, Charleston became more and more a prominent centre of influence, and here there lived and died during the century a group of five men, namely, Chalmers, Lining, Gardner, Moultrie and Bull, who made important contributions to science and achieved unusual distinction. All of these were of Scotch origin save the last, of whom it was claimed that he was the first person born in South Carolina, as well as the first native to receive a doctor's degree. He was a pupil of Boerhaave, a graduate of Leyden in 1774. He gradually drifted into politics, as did Colden. Lining was perhaps the first American physiologist and published numerous papers in the 'Transactions' of the Royal Society. He also published the first American account of yellow fever, which was the scourge of the century, and which appeared to spread to this country from the West Indies. Moultrie achieved an honorable position. He had a son who was also a doctor, and while both of them attained a high place in the esteem of their fellow-citizens, the death of the father was regarded as a public calamity, after some 40 years of phenomenal activity. Chalmers was already a friend of Colden and the others when he came to this country. He made himself generally known as a writer and developed power which would have made him, under suitable surroundings, a rare teacher. Gardner, like Colden, was a man of culture and fine education; in fact one of the most versatile men of his century in this country. He was made a Fellow of the Royal Society. To these should be added, perhaps, John Mitchell, an Englishman by birth, who came to this country in 1705 and made a reputation which spread to the centres of learning in the old country. He published a number of essays in the 'Philosophical Transactions.'

A great epoch in the medical history of the 18th century was the foundation of the first hospital in this country. This must be duly credited to the energies of Benjamin Franklin, Dr. Thomas Bond and, later, Drs. Shippen and Morgan. Bond was born in 1712, in Maryland. After studying for six years in this country he went to Europe, whence he returned full of the idea of introducing the hospital system which had proved so advantageous abroad. Though he returned in 1734, not until 1751 were circumstances sufficiently propitious to found something more than a mere camp for the treatment of smallpox or a lazaretto for the care of sick seamen. Franklin threw the whole weight of his influence into this movement and finally £2,000 raised by private subscription, added to a similar sum contributed by the colonists, prepared the way for the opening of the Pennsylvania Hospital in 1752. After four years of existence in rented quarters, the cornerstone of a new building for that purpose was laid, bearing an inscription suggested by Franklin himself. This institution had an enormous influence in more than one respect, since its foundation had made possible the creation of the first medical school in this country, which became a part of the University of Pennsylvania, and which owes its inception to the study and liberal enthusiasm of Morgan. Although Harvard College was founded in 1636 and Yale in 1701, it remained for this to become the pioneer medical school in the United States. Albany has a somewhat famous history regarding civil and military hospitals.

Previous to the American Revolution it had cared for many sick and wounded. Just before that period, in connection with the French and Indian wars, it had established a military hospital with accommodations for 500 patients. This was in use during the fighting along Lake Champlain, Lake George, Ticonderoga, Fort Edward, Bemis Heights, Saratoga, Schuylerville and the campaign of the Revolution. Later, during the epidemic of cholera, in 1832, barracks were erected for care of the sick; also in the beginning of the Civil War a large hospital was erected, much in the style of the barracks of to-day, and to this were brought the sick and wounded from about Richmond during the fighting under McClellan.

John Morgan began his study during the period of the French and Indian wars. As he came in contact with the foreign surgeons who came over with the English troops, he found his own ability not at all commensurate with his ambition. So in 1760 he went to London and studied under the Hunters, and then to Edinburgh, where he came under the influence of Cullen, the Munroes and others, and where he graduated. He next went to Paris and was admitted to the Academy of Surgery; he then made a tour of Europe, having the advantage of a personal acquaintance with Morgagni in Padua. Morgan spent five years in this foreign study and upon his return, in 1765, became closely associated with the younger Shippen. The Shippens were a well-known medical family of Philadelphia, and were men of liberal education and social distinction. Shippen had already given private instruction in midwifery and the two men joined hands most heartily in this commendable effort. When the trustees of the college opened the school Morgan and Shippen became professors, respectively, of medicine and surgery. Thus it will be seen that Shippen was the first professor of surgery in this country, and that the first systematic instruction in surgery was given by him in 1765.

The faculty was joined a little later by Benjamin Rush, who became the most conspicuous figure of his day, as a professional man, in this country. He was but 24 years of age when he was made professor of chemistry, and he was but 31 years of age when he became a signer of the Declaration of Independence. The gathering war clouds of the Revolution dampened the ardor of all at this time, and the work of carrying on the hospital and medical school was exceedingly heavy and fell mostly upon the shoulders of three or four men. In 1779 the assembly revoked its charter which was, however, restored in 1793. In the meantime the condition of affairs in New York was not much better.

One man, however, stood out pre-eminently as an efficient physician and broad-minded citizen. This was Samuel Bard, whose name deserves to be closely associated with that of Rush. When he returned to this country in 1765, after a period of foreign study, he was inspired with the thought of founding a medical school in his native land. In 1768 he associated with himself, Clossy in anatomy, John Jones in surgery, Middleton in physiology, Rush in chemistry, Tennent in obstetrics, he himself taking charge of the principles and practice of physic. Thus the medical school of King's College was established. Jones was perhaps the first in this country to distinguish himself as a surgeon. He had been under the best teachers in Europe, and had seen a great deal of military surgery in his day, especially during the French War. He was independent enough to decline to adopt some of the peculiar notions of his colleagues regarding appropriate costumes, but in the end the absurdities which he dispensed with were discontinued by them. He wrote a book for the Revolutionary surgeon, entitled 'Plain, Concise and Practical Remarks on the Treatment of Wounds and Fractures.' Up to this time, midwifery had been practised by untrained women and it can readily be seen what an advantage it was to have the science of obstetrics systematically taught as it was in both schools above mentioned.

During the six years while New York was occupied by British troops there was a cessation of college activity. The faculty was not a unit in its political beliefs and after the Declaration came dissensions. Three years after the war the college went on under its new name, "Columbia," but with very poor success. A spurt was made again in 1792. In 1807 the New York University opened a medical college, but jealousy and strife prevented its success. Finally, in 1811, a union of the two schools was accomplished under the name of the younger and thereafter the College of Physicians and Surgeons prospered and is to-day one of the leading schools in this country, though now again under the ægis of Columbia. Meantime under Bard's influence, the New York Hospital had been founded in 1768 and chartered in 1770. It was in their new building that the Provincial Congress used to meet during the second year of the Revolution; but when the British arrived the hospital was turned into a barracks and Bard and Jones joined the Continental armies. It was not until 1791 that the hospital was fully and finally equipped and began its career of usefulness.

The Revolutionary Period.—At the time of our Revolutionary War the science of military surgery was scarcely yet created and even with the Continental armies the barber-surgeon had a certain place, in which he was almost a menial, and above which he could scarcely raise himself. The English troops were better equipped in this respect than were the Hessians, for instance, while during the latter part of the war, especially when the French sent some of their best men to this country, our raw and untrained army surgeons came in contact with a better class of men and by whom they were, to some extent, inspired. Nearly all of the prominent medical men, save the Tory physicians of Massachusetts, entered the army or took public service, and in the Massachusetts Provincial Congress of 1775 there were 22 physicians. Both the colonial and general governments dealt very stingily with their medical departments and the professional equipments provided were almost meagre. The history of surgery in those days is mostly the history of a few prominent individuals who made it what it became and who deserve to be briefly mentioned. The brothers Joseph and John Warren took a very prominent part during the earlier portion of the war. It was the former who started Paul Revere on his famous ride. He was elected president of the Provincial Congress and just before the battle of Bunker Hill was made major-general of the Continental forces, preferring this office rather than the office of physician-general which he had been offered. During the battle he showed a wonderful spirit of self-sacrifice and, declining his rank, acted as a private, and with musket in hand fought nobly, and was shot dead just at the conclusion of the battle. The younger brother, John Warren, lived to achieve fame and reputation, and transmitted them to a posterity by whom they have been well preserved. He constituted a brilliant contrast to many of the regimental surgeons who had been too often appointed by political influence without regard to attainment. Some regiments were even organized without a surgeon and came into camp without the slightest provision for disease or injury. In 1776 Congress enacted that there should be one surgeon and five assistants to each 5,000 enlisted men. The former was to be paid $1.66 per day and the latter each $1 a day. The reader can imagine the care 5,000 men would receive from six physicians whose services were compensated at this rate. At that time such a thing as camp hygiene was almost unknown and a hospital corps and ambulance drill were quite lacking. But John Warren, then but 23 years old, proved extremely efficient in the organization and completion of, and accomplished a great deal for the improvement of his department. The first surgeon-general of the Continental armies was Benjamin Church, of Boston, who was given the title of director-general and chief physician and was paid $4 per day. Church gave promise of efficiency in his department, but before long was detected in correspondence with the enemy, for which he was court-martialed, imprisoned for one year and allowed to leave the country and was then probably lost at sea. His place was taken by John Morgan of Philadelphia, already mentioned above. He had the politicians to fight and after a long and arduous struggle, failing to satisfy them, he was dismissed from the service, although he was finally acquitted of all blame. This was a time of unrest, excitement and suspicion and had Washington himself been a weaker man, he could scarcely have withstood the dissensions and jealousy with which he was continually surrounded. Morgan was succeeded by Shippen, his old associate, who remained in office from 1777 to 1781. Under his guidance the medical department almost prospered and was at least conducted with dignity and great benefit to all concerned. Smallpox, which had been the scourge of the soldiers as well as the people in general, was kept down by the practice of inoculation, which had been generally accepted by nearly all men from Washington down.

From the Revolution to the Civil War.— The most conspicuous figure in the history of American medicine, which practically began with the conclusion of the Revolutionary War, was Benjamin Rush, of Philadelphia (1745-1813), an exceedingly versatile, many-sided, erratic, obstinate, skeptical man, constant only to his religion which he considered to be a professional duty. He was hated by many of those to whom his methods most strongly appealed. He had rare didactic gifts, but his teachings were abused by his students and followers. As a young man he had spent three years in Europe and had taken his degree at Edinburgh. He had come especially under the influence of Cullen, whose views he had imbibed and later accepted in a modified form. He served two years in Congress, where he advocated and signed the Declaration of Independence. In the same year, 1776, he got his first army medical experience. Rush seems to have been one of the few men who failed to come under the influence of Washington's personal magnetism, and he endeavored in some ways to belittle his commander-in-chief. After a rather ignominious exposure he retired from service and took up his practice in Philadelphia. From that time on he became noted as author, teacher, practitioner and politician. He proposed a cabinet position whose incumbent should be called Secretary of State for Peace. He wrote extensively on many subjects, not all of which were medical. He finally exposed the weakness of Cullen's doctrine and fell rather into accord with that of his great rival, Brown. He taught that yellow fever was not contagious, but warmly advised purgation and excessive letting of blood in its treatment. At his death he was one of the few surviving signers of the Declaration of Independence. He made many contributions to science and it is said of him that since the death of Washington no man was so deeply and universally mourned. A list of his writings would include several pages of titles and would show the mental and physical activity of this great man.

The earlier portion of the 19th century in the large cities of the country was characterized by unfortunate dissensions and jealousies which for many a year kept back medical progress. Prejudice against the study of anatomy was as strong as ever, and the difficulties surrounding dissection were often very great. The so-called "Doctor's Mob" occurred in 1788, when an excited crowd tried to break up a dissection which was being carried on in the old New York Hospital, where the provincial legislature at one time held its sessions. The students and doctors took sanctuary, for the time being, in the jail, the militia were called out, seven rioters were killed and the doctors got no sympathy. Although this was before the 19th century actually began, it nevertheless indicated the spirit of the times. The great benefit of the Revolution came from the presence of the educated and more cultured French and other foreign officers who came to this country and brought their books and wisdom with them.

The greatest figure in American surgery during the earlier part of the previous century was Philip Syng Physick. He was born in 1768 and died in 1837. He came of a good family and had a good education. But it was not until 1789, when, in London, he had the good fortune to be taken into the family of John Hunter, that he developed those qualities which helped to make him great in after life. Had he been willing to remain in the old country he might have become Hunter's partner. He had the best that the old country could afford, spending some 11 years in study, all told, which was a remarkably good preparation for practice 100 years ago. He yielded to the claims of his native land and quickly built up a practice after his return to this country. He had much with which to contend, including indigestion, an absolute lack of humor, in fact a temperament such as to make him unpopular, the only thing that saved him from this being his brains. In spite of all this he left behind him the reputation of being the Father of American Surgery. One of his most celebrated cases was that of Chief Justice Marshall, from whose bladder he removed an astonishing number of calculi. In 1805 he became professor of surgery in the University of Pennsylvania, which chair he held for 13 years. Though clumsy and uncouth in person he was singularly dexterous with his hands, and excelled in deftness with the knife, and with all forms of orthopedic apparatus. He gained great reputation in his treatment of fractures and dislocations, many modifications of which he made which proved very advantageous. For some years he had promise of a successor in his nephew, John Dorsey, who, however, died before his uncle, and never lived out his promised career.

The next great figure in American surgery was Ephraim McDowell, who came from what was then called the «Far West,» in Kentucky. When young he went to a classical seminary, where he got a smattering of Greek and Latin, but did not conclude to study his profession until he was 20. He began reading medicine in Danville, Ky., but was finally sent to Edinburgh by his father. Here he came under the influence of John Bell, whose teachings made him what he became. He returned in 1795 and decided that there was a rare opportunity in Kentucky for an educated physician, in which matter his foresight proved correct. In 1809, when he undertook the first and great historical 'Ovariotomy,' he was already known as an accomplished and educated man, upon whose mind the teachings of John Bell had made a great impression. When Mrs. Crawford came to him, suffering from an ovarian cyst, he was ready to undertake her case despite the protests of others. The case terminated favorably, but it was not until he had performed a number of similar operations that he thought it best to publish anything on the subject. Even then his paper did not see the light as it should, and there was for a time a doubt in the minds of those who should have known better as to whether his report was really authentic and whether he should be credited with this pathfinding expedient. He has been amply vindicated, however, and this fortunate experience of his paved the way for many operations but for whose effects thousands of lives would have been sacrificed.

The next great figure was Valentine Mott. He was born in 1785, and was of Quaker parentage. He was a great classical student, and was well equipped for professional study when he began to study medicine. He then spent two years in Great Britain, especially in London, which was then rich in famous surgeons. Under Hunter, Cooper, Abernethy and Charles Bell he acquired that familiarity with surgical anatomy which was a great help both then and in later years. He returned to New York in 1809, and his personal traits as well as his thoroughness quickly brought him practice and made him known. He became the teacher of surgery in the Columbia School until he transferred his activities to the new school which resulted from the union of Columbia and the College of Physicians and Surgeons, where he lectured for 56 years, inspiring in his classes constant enthusiasm and eagerness for work. The influence of his insistence upon the importance of anatomy still persists, and was brilliantly demonstrated by his work upon the blood vessels. It is said that he tied more large vessels than any other surgeon living or dead. Perhaps his greatest achievement, at least the one that made him most famous, was ligature of the innominate artery. This first operation of its kind was not permanently successful, nevertheless it stamped the operator as a man of wonderful resource and daring. The first successful case belongs to another American surgeon, A. W. Smythe, of New Orleans, who tied at the same time, the carotid artery in the neck. Again he won great repute by removing the entire clavicle for a large tumor. In 1827 he tied for the first time, successfully, the common iliac artery. The previous operation had been made by another brilliant American surgeon, Gibson, of Baltimore, whose patient unfortunately died of peritonitis. In 1835, quite broken in health, he made a tour of Europe, which had about it much of a triumph, inasmuch as he was everywhere received with éclat.

We have already recounted how John Warren served in the Revolution both as a surgeon and patriot. His son, John Collins Warren, was born in 1778, and was reared in an atmosphere of study and refinement. He was thoroughly educated for his work, in which he took the greatest pride, and, like Mott, had the advantage of the teachings and friendship of the most distinguished foreign surgeons. Two events of importance, in which he was conspicuous, were the founding of the Massachusetts General Hospital, and the introduction into surgery of the then new anæsthetic, sulphuric ether, of which we shall have more to say below. He was a bold operator and for his operations on bones, especially the jaws, he became famous. He gathered a memorable collection of his personal cases in his 'Surgical Observations on Tumors,' which are to-day most instructive. He was the founder of the large collection of specimens now known as the Warren Museum, in Boston.

While Warren and Mott were making their great reputations in the East, it remained for Kentucky to produce still another even greater than McDowell, in the person of Benjamin Winslow Dudley, born in 1785, who began life in an obscure way and who raised himself to eminence purely through his own attributes and strength of character. While quite young he made enough money, by a shrewd enterprise, to take him abroad where he remained several years, returning a polished and educated gentleman. Cooper and Abernethy in London, and Larrey in Paris, were men for whom he had much admiration and with whom he became well acquainted. When he returned he was 29 years of age, matured and devoted to his science. As a measure of his success it may be said that in his first 100 cases of cutting for stone in the bladder he lost not one; a statement that could be made by but few surgeons to-day. His early work in the surgical treatment of epilepsy directed attention to what could be done in this almost hopeless disease, and his treatment for hydrocele by excision of the sac is in common use to-day. For 20 years he was prominent in the Transylvania Medical School, in Lexington, Ky., which was later merged into the College of Louisville. Dudley wrote very little, but his personal influence was extraordinary, and he was without doubt the leading practitioner of the West. He died in 1870.

In the interest of economy in space, it will be best, perhaps, to recount the various historical achievements of American surgeons without going into further biographical details. In the department of surgery of the large blood vessels the American surgeons were almost pioneers. In 1803 Cogswell of Hartford tied the common carotid, making the first successful ligation of this vessel on record. In 1807 it was first successfully tied for secondary hemorrhage by Twitchell of Keene, thus antedating Astley Cooper's famous case by eight months. In 1813 Post of New York first tied this artery for the cure of aneurism. In 1823 MacGill of Maryland first successfully tied both carotids simultaneously, the case being one of fungus tumor in both orbits. In 1867 Carnochan of New York first tied both carotids for the treatment of elephantiasis of the face and neck. Post, in 1817, first tied successfully the subclavian artery in its third portion, after it had failed in the hands of some of the great English surgeons. The same artery was first tied in its first portion by Rodgers of New York, an operation hitherto considered impossible, and which was never successfully repeated until 1892, by Halsted, of Baltimore. Mott's first ligation of the innominate artery has already been mentioned, an operation which made him famous all over the world. The internal iliac was first tied by Stevens in 1812, the external by Dorsey in 1811, and both internal and external by Dennis in 1886, while Davidge first tied the femoral and gluteal for the cure of elephantiasis of the lower extremity. Digital compression for the relief of aneurism was first successfully practised by Knight of New Haven in 1848. The use of the elastic bandage in the treatment of varicose veins was first successfully adopted by Martin of Boston, who preceded Estmach in the use of this expedient for controlling blood supply during amputations; while Wyeth recently introduced long pins for the same purpose in amputation of the shoulder and hip.

In fractures and treatment of injuries and diseases of bones and joints, Physick exceeded all men, without question. The so-called American method, which is now so widely accepted, that is, the treatment of fractures by traction with a weight and pulley, was introduced by Daniel of Georgia. Van Ingen of Schenectady added to the method the elevation of the foot of the bed, and Buck increased its value by his coaptation splints. The present universal method is, therefore, a composite of all these, but is distinctly American. So is also the use of elastic traction by the aid of rubber bands. Barton, Bond, Hamilton and Reid, the latter of Rochester, all studied assiduously the mechanism of fractures and dislocations, and described the methods for their treatment and relief. The interdental splint for the treatment of fractured jaw was also of distinctly American origin. Rodgers introduced metallic sutures in the treatment of fractures; Brainard of Chicago, the method of drilling fragments in delayed union, while both Henry Smith of Philadelphia and Nathan Smith of New Haven did very much to improve apparatus for the retention of fragments in their proper place.

In the treatment of dislocations, especially in the matter of their reduction by manipulation, the world owes a great deal to Reid and Moore of Rochester, Bigelow of Boston and Gunn of Chicago, by whose efforts it was brought about that the ponderous machinery of the clinics was completely abandoned. In the removal of diseased bones Jamieson of Baltimore, in 1820, made the first resection of the upper jaw, while the upper and lower jaws were both simultaneously removed by Rodgers of New York. The first removal of the lower jaw was by Deaderick of Tennessee in 1810, while the clavicle was first successfully removed for necrosis by McCreary of Kentucky, in 1803, and for malignant disease by Mott in 1828, and the entire upper extremity, including the scapula and clavicle, by Crosby in 1836, and again the entire radius in the same year. Stone first removed a rib for drainage in 1862, and Mott the coccyx in 1832. Wood of New York had a famous case of entire removal of the lower jaw with almost complete reproduction of bone. Other operations of importance on bones were the first removal of a «V» shaped piece of the hip, and also for the cure of bony anchylosis of the lower jaw. Nathan Smith of New Haven is entitled to the credit usually given Brodie for the trephining of inflamed bones for the relief of inflammation and abscess.

In the matter of amputation Richard Bailey is to be credited with the first systematic amputation of the shoulder joint, in 1762. Crosby's case of the removal of the entire extremity has already been mentioned. The first successful amputation of the hip was made by Brashear of Kentucky in 1806. The patient was a slave boy belonging to the monks of Saint Joseph's College. The first operation of this kind ever done was in England by Kerr in 1774; while the first done for gunshot wound was by Larrey in 1793. American surgeons also made many improvements in genito-urinary surgery. The first successful plastic operation for exstrophy of the bladder was made by Pancost of Philadelphia in 1858. He and others preceded Wood and various English surgeons to whom the credit is usually given. Parker of New York introduced cystotomy for the relief of chronic cystitis. The kidney was removed successfully by Wolcott and by Stoddard of Milwaukee nine years before it was removed by Simon of Heidelberg, who has been credited with it. The first really successful method of operation for cleft palate was introduced by J. C. Warren of Boston, while Cheever, another Boston surgeon, was the first to remove the tonsils by external incision.

In abdominal surgery Americans have almost led the world. Had it not been for McDowell's epoch-making case, in 1809, this branch of surgery would have been much retarded. Any one practising to-day can scarcely realize the moral courage and surgical daring required during that historical incident. Atlee of Philadelphia and Kimball of Lowell were the first to successfully remove large uterine fibroids, and it is claimed that Stevens of South Carolina, as early as 1763, successfully removed the entire uterus, an operation repeated by Briggs in 1830. The first vaginal operation for extra-uterine pregnancy was made by King of South Carolina in 1813, while the abdomen was first opened for this purpose by John Baird as early as 1759. Bobbs of Indianapolis was the first to attack the gall-bladder surgically, while Willard Parker first made clear the surgical treatment of peri-appendical, or as it was then called, perityphlitic abscess. The entire elucidation of the surgery and pathology of appendicitis is due to Americans, especially to Fitz and McBurney. The treatment of gunshot wounds of the abdomen by abdominal section was conceived, developed and perfected in America, especially by Bull and Parkes, while Senn, Murphy and others have made valuable contributions. The first four cases of pancreatic cyst were in the hands of American surgeons. The surgery of the female genital organs owes more to the ingenuity and skill of Americans than to those of all other nationalities combined. Especially valuable in this direction were the labors of Sims and Emmet. Other procedures of distinctly American origin might be named without making the list too long; for instance, the invention of skin grafting by Dr. Frank Hamilton of Buffalo in 1854. The same procedure was independently instituted by Reverdin of Geneva, Switzerland, each being independent of the other. Animal ligatures were first used by Physick in 1844. The innocent character of the metallic ligature, as well as its usefulness, was first demonstrated by Levert, of Mobile. The use of plaster-of-paris splints and jackets was greatly promoted by Sayre of New York, although he was not their originator. The first abdominal section for gunshot wound of the intestines was made by Kinloch of Charleston in 1881. The discoveries and inventions of American orthopedic surgeons have been models for the rest of the world.

The two great events in the history of American surgery in the 19th century were the introduction of anæsthesia and the antiseptic technique. Both stand to the credit of the Anglo-Saxon race, the former being an American, the latter a British device. These two measures together wrought a complete revolution in the practice of surgery, and show that the Anglo-Saxons have done more for it than had been accomplished in the previous 18 centuries. By the latter the devastations of sepsis have been almost completely done away with; and by the former the tortures of pain and the agonies of serious and protracted operations have been abolished.

Period of the Civil War.— The exigencies of the Civil War made demands upon the medical resources of the regular and volunteer armies which at first could not be adequately met; in this as well as other respects both sides were but meagrely equipped either with men or means. It was before the days of antiseptic surgery, bad methods still prevailed and the sacrifices then made to sepsis and to bad sanitation were fearful to contemplate. Wounds of large joints condemned the patient to amputation above the injury, compound fractures were very generally, fatal, hospital gangrene and tetanus were like spectres which stalked by night through the hospital camps. With characteristic readiness measures were rapidly adopted to minimize the slaughter from disease, and within a comparatively short time a well-equipped medical corps, backed by the government Sanitary Commission, had brought order out of chaos, while the Red Cross Bureau had shown what it could do, especially under the guidance of Miss Clara Barton and other devoted women. Military surgery was but emergency surgery practised under peculiar conditions, and as this fact became more greatly appreciated our wounded soldiers received better and better care. The outcome of this extended experience, in two or three different and indirect ways, was remarkable. It led to the foundation of the Army Medical Museum, in Washington, which has since grown to enormous proportions and now occupies the larger portion of a large building, wherein everything pertaining to so-called military surgery finds ample illustration. It led also to the building up of the wonderfully rich and complete library of the surgeon-general's office, with most extensive index catalogues, including the Index Medicus, by which the entire medical literature of the world is catalogued and made available to all. And, thirdly, it led to the publication of the Medical and Surgical History of the War of the Rebellion, in six enormous volumes, which far exceed in magnitude and value anything of the kind ever published. In their efforts to build up these three features the names of Otis, Huntington and Billings will ever stand preeminent.

From the Civil War to the Present Time. — The Civil War developed very many excellent American surgeons, and within a decade after its close the good effects of their experience were manifested in a great many of the civil hospitals throughout the country, particularly in the practice of men who had located in the larger cities and towns. This, together with the development of asepsis, brought out a great deal of beneficial work in this country, in the practice of surgery. It also presented a period when specialists began to develop with greater precision than at any time in the previous history of medicine. This was especially true in regard to gynecologists, and, what at that time were termed, abdominal surgeons. The outcome has been the organization of several national surgical associations, which have included in their fellowship some of the ablest surgeons in the United States, thus enabling America to keep thoroughly abreast of all that was being done elsewhere. There has been a progressive development of bacteriological, biological and pathological laboratories where much research work has been accomplished, aiding very decidedly in the better understanding of surgical lesions, and resulting in a great increase in the possible operations to be performed for relief of the patient. Had the elder Gross, in his early experiments, in 1843, known of or had a laboratory at his disposal, such as exists to-day, greater honors would have come to him in doing intestinal surgery.

Laboratory work, with increased surgical skill, has brought about the establishment of many hospitals in the larger and smaller cities, and it may safely be asserted that in the latter many strong surgeons in the World War just brought to an end will be found doing superior work. Many of these institutions will feel the good impulse of benevolence, excellent nursing and support from Red Cross organizations, while the larger hospitals in cities will become better endowed and less embarrassed in meeting their financial obligations.

It is very impressive to note how willingly communities have accepted going from their homes to the hospitals for treatment. Research work has brought out many surgical conditions associated with illnesses heretofore considered medical, such as lesions of the bones following typhoid fever, also tubercular conditions of the joints, syphilis, actinomycosis and other obscure lesions of internal organs, this advance being conducive to recoveries of cases formerly doomed to a long, painful sickness. Our laboratories have been of incalculable value in the preparation and standardization of absorbable ligatures; in the examination of the blood, and various secretions, and, especially, in the development of tetanus, antitoxin and other serums.

One great advance made by American surgeons has been the surgical treatment of the thyroid gland; another the energetic manner in which they have attacked the gall-bladder, the stomach, the intestinal tract, the spleen, pancreas and the reproductive organs within the pelvis, for conditions considered quite hopeless in the past. Operations upon the appendix, and intestinal tract, with the ability to remove portions of the latter, yet allow normal functions to follow in a healthy manner seem wonderful. This same confident development of surgical procedure has eliminated much of the distress due to lesions of the kidneys, the ureters, the bladder and prostate gland. All of this work could not have been accomplished without our knowledge of pathological micro-organisms, and the employment of sterilization of the operating-room, the field of operation, the operator and dressings.

American surgeons had much to do with the evolution of this chapter in surgery. From the introduction of the carbolic spray, as taught by Mr. Lister, through all the various experiments in the use of antiseptics, and, finally, of asepsis, much has been accomplished. The battle has been to control suppuration — i.e., the formation of pus — and when every precaution has been carried out, when no link in the chain of technic of procedure has been omitted, to the public at large the recovery of patients becomes very noticeable.

In successful work surgery made a stride that commanded the respect and attention of wealthy citizens with a benevolent trend of thought, so that hospitals and laboratories were endowed, and in America we were able to do what for some time seemed only to be known in Europe.

Through the study of germs, in the various laboratories, and their danger to operative surgery, and with the employment of absorbable ligatures, the science and art of surgery has been brought up to a very high plane of activity. The advances made in operations upon the spine, and the transferrence there of splinters from the long bones of the body, for the treatment of curvatures, has been one of the most decided advances in surgery. This is also to be observed in the immobilization of wounds, as illustrated in the fixation of fractures of the extremities.

Very much credit is due the American surgeon for discoveries and advances in local anæsthesia in operative surgery, in hospital construction and for the persistent use of rubber gloves, particularly when operating in septic cases.

Some of the most brilliant advances made in surgery of the nerve trunks, in the removal of the Gasserian ganglia, for relief of neuralgia, has been accomplished by the American surgeon. The investigation, study and progress made in the department of genito-urinary surgery is one of the most convincing arguments that surgery has become more of a fixed science than ever in its past history.

The genius of the American surgeon is well shown, in so many ways, by the invention of new instruments, as well as the improvements made in those long in use, and in hospital furniture.

History of Anæsthetics.— The abolition of pain is in itself a matter of such vast interest and humanitarian importance that a brief history of the introduction of anæsthetics should be much appreciated, especially in a rehearsal of American achievements. Strictly speaking, the term anæsthesia refers to the abolition of sensation of all kinds, whereas for the prevention of pain the term analgesia should be used. The distinction is an important one in certain cases; for instance in the injection of cocaine solution into the spinal canal, it produces the latter without the former, whereas by the use of the anæsthetics now in use general anæsthesia is produced. By general consent the term is restricted to complete loss of consciousness produced by such drugs as ether, chloroform and nitrous oxide, and not to the intoxication produced by drugs like opium, hashish or the mandragora of the old writers. The substance known as sulphuric ether had been known by the mediæval alchemists in 1540, and was spoken of as sweet oil of vitriol. It was not called ether until 1730. In the earlier years of the previous century it was often inhaled for experiment or diversion because of its peculiar exhilarant effects. Nitrous oxide gas had been previously used for the same purpose, and even for the production of anæsthesia. It will be seen, then, that these two anæsthetics had been well known for some of their properties. Chloroform, on the other hand, was not discovered until 1831, and not recommended as an anæsthetic until 1847. The honor of the introduction of ether into surgery is claimed for at least four men, Long, of Georgia; Jackson of Massachusetts, who were physicians; Wells, of Vermont, and Morton, of Massachusetts, who were both dentists. The first public demonstration of the value of ether as an anæsthetic agent, for the prevention of pain during surgical operations, was made 16 Oct. 1846 by Morton, at the Massachusetts General Hospital, before a group of men including some of those already mentioned in this article, especially Warren and Bigelow. In all probability Long antedated this event by its use for a similar purpose in 1842, but in those days in this country the population was sparse, means of travel very slow and no public record of the event was ever made; in fact no account of Long's work appeared until 1849. To Wells probably belongs the credit of first producing anæsthesia by nitrous oxide gas, when he took it himself in 1844. After his own happy experience with it he began its manufacture and introduction to the profession. In 1845 Wells visited Boston, and even called on his old partner, Morton, endeavoring there to introduce his new compound for surgical purposes, but met with no encouragement. In Hartford there stands to-day a monument erected by the public, bearing the following inscription: «Horace Wells, who discovered anæsthesia, November 1844.» Morton had been a student in Wells' office, but not being a good chemist he consulted Jackson, whose office he later entered, and by whom he was advised to experiment with ether. Jackson told him, for instance, that the students at Cambridge often inhaled it for amusement, and in 1846 he first gave it for the extraction of a tooth, the patient stating that he felt no pain. Then came efforts to patent the new anæsthetic which were not to the credit of either Jackson or Morton. Finally came the public demonstration above alluded to, when Morton administered his «letheon,» and Warren removed without pain a tumor from the neck of a young man. At this time Morton endeavored to disguise the odor of the substance he was using so as to prevent its recognition, and it was not until the hospital staff declined to use any substance whose composition was kept secret that Morton revealed his discovery. During the ensuing years there took place a most active and acrid controversy between the partisans of the men most concerned in the introduction of ether into surgical work, as to the respective merits of their various champions.

A dispassionate judgment of the whole indicates that to Wells, doubtless, the credit of the introduction of nitrous oxide belongs. Long probably was the first to use ether in a surgical way, but was slow in making his results known. Morton finally became the promoter of the new agent, partly by virtue of his own energy and partly because of his acquaintances and surroundings. Chloroform, although discovered independently by Guthrie, of Sacketts Harbor, N. Y., in 1831, was introduced into surgical work by Simpson, of Edinburgh, who advised it especially for the relief of the pangs of childbirth, and who was, in consequence, violently assailed by the Scottish clergy as interfering with the spirit of the primal curse which read, «In sorrow shalt thou bring forth children.» Simpson, however, disarmed his opponents by a quotation, also from the Scriptures, to the effect that when God created Eve from one of Adam's ribs, he «caused a deep sleep to fall upon Adam.» It will hence be seen that, at the date of this writing, it is almost 70 years since it became possible to make surgical operations painlessly. What this means both for the surgeon and the patient will be appreciated, while what it has made possible can be easily realized by contrasting the resources of the surgeon of to-day with those of the middle of the 19th century. See VIVISECTION — ITS INFLUENCE ON SURGERY.

ROSWELL PARK,
Author of 'Text Book of Surgery.'
ALBERT VAN DER VEER,
Professor of Surgery, Albany Medical College, 1878–1915.

SURGICAL ASSOCIATION, American, a society organized in 1880, the objects of which are to promote the improvement of the science and art of surgery. The active membership is limited to 125 Fellows and the honorary membership to 25 Fellows. An applicant for Fellowship must be 30 years of age, a graduate of five years' standing from a recognized medical college and have an established reputation as practitioner, author or investigator. Meetings are held annually and an annual volume of *Transactions* is published. Every third year the association joins with other associations constituting the Congress of American Physicians and Surgeons in a meeting held in Washington, D. C.

SURICATE, or MEERKAT, a South African civet (*Suricata tridactyla*), which differs from typical viverrines in several points, notably in having only four toes on each foot. It is dark brown and has dark transverse stripes on the rear of its back. The body and head reach a length of 12 or 13 inches, the tail six inches and the animal has a general resemblance to a small raccoon, but the tail is more catlike. It lives in caves and rock-caverns or sometimes digs burrows. It is diurnal, lives mainly on roots and barks like a dog. Consult Martin, 'Home Life on an Ostrich Farm' (New York 1903).

SURIGAO, soo-rē-gä'ō, Philippines, (1) Town, capital of the province of Surigao, Mindanao, on the extreme north coast of the island of Mindanao. This district was the site of the first Spanish mission in the Philippines; in 1879 a series of earthquakes caused the ground in the neighborhood of the town to sink two feet and many of the government buildings were rendered uninhabitable for a time. The chief industries are the gathering and export of pearl shells and trepang and the placer mining of gold. Pop. 7,749.

(2) Province, island of Mindanao, occupying the northeastern part of the island; area, 6,988 square miles. The principal dependent island is Dinagat, lying off the north coast;

it is mountainous, heavily wooded and has deposits of gold; area, 387 square miles; the second island in importance is Siargao (q.v.), 190 square miles. The mainland of the province is traversed by two mountain ranges, extending from north to south, one near the east coast, the other forming the western boundary; spurs of these ranges extend in both directions. The central valley is drained by the Agusan River, one of the finest in the Philippines. Cotton, hemp, rice, sugar, tobacco, indigo, etc., are cultivated; the cocoanut, betel nut and betel pepper are grown for export. Gold is found in the mountains and in the sands of the mountain streams and is mined; the forests are valuable, and gums and resins are obtained in large quantities; fishing is an important industry, and there is some weaving of native fabrics for home use. There are few roads, the communication is by sea or by the rivers and lakes of the central valley. Civil government was established in the province in May 1901, but the jurisdiction of the provincial government does not extend to the non-Christian tribes. Pop. 115,112.

SURIGAO, Strait of, connecting the Sulu Sea with the Pacific, having Mindanao on the south and the islands of Leyte, Panaón, Bohol, Cebu, Negros and Samar on the north. It was the route taken by Magellan after crossing the Pacific. The San Bernardino Strait is now used more than Surigao during certain seasons, but Surigao is the more direct, deeper throughout and the more advantageous route for vessels bound for the southern Philippines.

SURINAM, soo-rĭ-näm'. See Guiana.

SURINAM TOAD, or PIPA TOAD, a toad of the South American family *Pipidæ;* specifically *Pipa americana.* It is one of the largest and the most repulsive-looking of the toads and is noted for its extraordinary mode of developing the eggs and young. When the female is about to expel her eggs the male mounts upon her back and the eggs as they are extruded are squeezed upward between the back of the female and the belly of the male, where they stick to her skin and gradually sink into the spongy skin, each occupying a pit with a lid. Fertilization takes place by some process not well understood just before the extrusion of the ova. The eggs remain in the pits until they have reached a mature condition (although yet very small) and then escape into the water. Consult Gadow, 'Amphibia and Reptiles' (New York 1901).

SURMULLET. See Mullet.

SURNAMES. A surname is a name added to a baptismal or Christian name which makes it more specific, and is generally a family designation. It may be indicative of descent, habitat, craft, or may have originated in totemistic associations, clanship, personal peculiarities or from vulgar nicknames. A proper name, once given or adopted, becomes in time a part of the individuality. The giving of names is not necessarily proof of an advanced civilized condition. It may be considered coeval with and intimately connected with the gift of speech; the Adamic tradition of the origin of common names is a self-evident proposition when applied to pre-Adamic savagery. The primal family grew into the primal tribe, and proper names became necessary; the land and the gathering of men upon it necessitated proper designations for each, or the same name for both.

All proper names have, at first, a peculiarly appropriate meaning, which in time often becomes obscured and ultimately forgotten. Schlegel traced descriptive epithets in almost all Hindu names, and the older names among the Hebrews, Arabs, in fact all Oriental nations, are highly significant and grotesque; as, "son of wool," "son of wealth," "son of the scythe," "young of dog," "prince of the dogs" among the Tcherkessians of Mount Caucasus. This is measurably true of names of Aryan origin, and noticeably those of Teutonic and Scandinavian lines. The North American native is usually named from some animal, for totemic reasons, and later earns another from some deed of daring performed; and similar practices prevail in all savage tribes. In fact, the origin of heraldry may be looked for in totemic devices and symbols.

The study of proper names is useful in historical and literary researches — as important as numismatics, heraldry, superstitions, symbolism and tradition. The name of a man often retains the impress of his country, and sometimes of the period in which he lived, and may thus furnish a clue to correct a date or vague notion, or to settle a disputed question in chronology, geography or genealogy; the conquerors of Andalusia, the Vandals, gave their name to that province, and it is hence not derived from Andalus, son of Japhet and grandson of Noah; the posterity of one man cannot, in reason, cover 30 degrees of longitude, in three generations, in a barbaric age.

In Rome, family or clan names were hereditary, but surnames remained individual, sanctioned by public consent, as Scipio Nasica, Piso Frugi, Lentulus Sura. In the republics of Greece, notably Athens and Sparta, men's names were significant of the power, valor, virtues or victories of the people, as Agesilaus, Charidemus, Demagorus, Demophilus, Demosthenes, Laodice. In fact it is common among all peoples to exaggerate the importance of the significance of names. Both Greeks and Romans augured well or ill from them. Grecian names are significant, either of religious feeling, the remembrance of great events, some happy omen, chance, friendship or gratitude. Daughters were named from their fathers more scrupulously than were the sons; Homer uses their names in this wise without exception, as Chryseis, the daughter of Chryses; Briseis, the daughter of Briseus. The son's name was frequently an enlarged form of the father's, as it was deemed that polysyllabic names were more honorable than shorter ones, which were given to slaves; the Spartan Hegesander named his son Hegesandrides, and Hiero, tyrant of Syracuse, named his son Hieronymus. There are traces of a desire to adopt family names, among the Greeks, but it generally ended in a vague reference to the hero from whom the family sprung; these surnames were only adopted by those families who pretended to trace back to deities or fabulous periods of history.

The Scandinavians and largely the Germans had none but individual names; every family, as with the Greeks, showed a decided preference for certain names, and these were generally transmitted from grandfather to grandson, or from uncle to nephew, for some occult reason, while the daughter was only known by her father's name (as Alf-hide meaning literally the child of Alf'r). Others retained the root from which the head of the family derived his name, but varying the other syllables (thus, the three sons of the formidable Argrim retained the last syllable which signified rage). There were thus no family names among the Celts, strictly speaking. The songs of the Druids have perished with the names of the heroes they sang of; but more fortunate were the heroes of Erin and Morven, for the ancient national songs still exist in Ireland and Scotland.

The need of surnames began to be felt. Many would naturally prove themselves «dreadful-in-the fight,» «Hardy,» «Stern-of-look,» and the Northern nations soon adopted a method of adding the father's name to the son's; as Oscar son of Ossian, Oscar son of Caruth, Dermid son of Duthnò, Dermid son of Diaran. The introduction of Christianity, which taught the equality of man, breaking up class distinctions, rapidly advanced the adoption of surnames by the use of new or baptismal names — Biblical or saints' names, anything but pagan cognomens — and this caused endless confusion; the new names were almost wholly derived from foreign languages, and as such had no local or personal significance.

The rise of feudal power was another source of change and confusion, as retainers or feoffees often bore the name of their overlord, whose title might arise from his office at court or his most valuable estate. The division of estates led to a new distribution of surnames among the heirs, taken from the inherited estates, only the oldest retaining the father's name by reason of the name being attached to the home-estate. The charters of the 10th and 11th centuries often recited the same individual under different names — sometimes because he had lost the manor which gave him title, or had come into possession of another which was more flattering to his vanity. The law of primogeniture finally cleared away much confusion, the property becoming settled in tenure and the owner desiring to proclaim his patent of nobility; from that time a surname was rarely lost and was further confirmed by the granting of armorial bearings.

In heraldry we find many surnames derived from «canting arms,» which clearly proceed from the arms; as in Sweden, the family whose arms represented the head of an ox took the name Oxenstiern (like the well-known Front-de-Bœf); the Racines had originally placed in their coat-of-arms a rat and a swan (Rat-Cygne), but the writer of «Athalie» retained only the swan, as the rat offended his taste.

To England the Saxons brought their feudal institutions; immense properties were attached to the king and his Thanes, and they farmed them out to substantial tenants who again let them to subtenants for cultivation. William the Conqueror redistributed these lands as fiefs among his Norman warriors; Henry I, in 1100, changed the fief tenure into real or freehold property, but his concession produced no great increase of hereditary names. In 1160 Henry II enfranchised the land in order to counteract the ambitious barons; soon after his time hereditary names became common in England.

It appears that surnames began to be adopted in England about 1000 A.D., coming mainly from Normandy. A few Saxons had surnames: «Hwita Hatte was a keeper of bees in Hœthfelda, and Tate Hatte, his daughter, was the mother of Wulsige, the shooter,» in the Cottonian manuscript shows a transition point. In the time of Edward the Confessor there were Saxon tenants in Suffolk: Leuric Hobbesune (Hobson), Suert Magno or Manni, Godric Poinc, Tedricus Pointel, Siuward Rufus (redhead) and Stigand Soror. In the Domesday Survey they were becoming more common: as Alwin Dodesune (Dodson), Walter Achet, Osmund Angevin, Roger Arundel, Walter Bec, William Bonvaslet; some of these being curious Norman blends of their own names with those of their Norman masters, as above in Arundel and Angevin. When King Magnus assumed Highland dress he became known as Berbeinn (Bareleg), still preserved, probably, in the Puritan «Barebones.»

The terminations *ing, kin, son,* in English names, were derived from the Norse *ingr, kyn* and *sonr,* the *r* being dropped. The Danish make the last sen. The diminutives: Friesian, *ken, ke, ock, cock* (a foolish fellow, hence the Scotch «gowk»); Norman-French *et, ette, let, ot, otte, el;* Old Norse, *i, a, ki, ka, gi, ga, ungr, ingr* and *ling,* became quite common additions to English names, which have since adhered.

The Gaelic *Mac,* Irish *O',* the British *Ap,* the Norse *ungar,* the Friesian *ingar* and *en,* the Anglo-Saxon *ing,* the Norman *Fitz* (probably from Flanders originally; many Irish families substituted Fitz for Mac in Norman times) are all ancient family prefixes. The ancient tribe of Waring or Wearing, the Vœringi or Veringun (originally from the Vœringifjord in Norway) formed the celebrated Varangian guard of the Byzantine emperors, which was afterward largely recruited from the North and especially from England.

In England, as of old in Schleswig, the village community formed the unit of English society. Each such township was still bounded by its mark of forest, mere or fen, which divided it from its nearest neighbors. In each lived a single clan, supposed to of kindred blood and bearing a common name. Many family names are thus perpetuated in England; as the Bassingas at Bassingbourne in Cambridgeshire; at Bassingfield in Notts; at Bassingthorpe and Bassingham in Lincolnshire; and at Bassington in Northumberland. The Billings have left their stamp at Billing in Northampton; Billingford, in Norfolk; Billingham, in Durham; Billingley, in Yorkshire; and Billinghurst, in Sussex. Birmingham, Nottingham, Wellington, Farington, Warrington and Wallingford are well-known names formed on the same analogy. In London alone occur the clan settlements at Kensington, Paddington, Notting-hill, Billingsgate, Islington, Newington, Kennington, Wapping and Teddington. There are altogether 1,400 names of this type in England.

Totemism consists in the belief that each family is literally descended from a particular animal or plant whose name it bears and members of the family formerly refused to pluck the plant or kill the animal after which they were named. The genealogies of the Anglo-Saxon kings include such names as those of the horse, the mare, the ash, the whale. In the ancient poem 'Beowulf,' two of the characters bear the names of Wulf and Eofer (boar); the wolf and the raven were sacred animals. The boar was greatly reverenced and our Christmas boar's head is a survival of the old belief. The oak has left its traces in Oakington, in Cambridge; the birch, at Birchington, in Kent; the boar (eofer) in Evringham in Yorkshire; the hawk in Hawkinge in Kent; the horse, at Horsington, in Lincolnshire; the raven, at Ravingham, in Norfolk; the sun, at Sunning in Berks; and the serpent (wyrm) at Wormingford, Worminghall and Wormington in Essex, Bucks and Gloucestershire, respectively. Every one of these objects is a common and well-known totem among savage tribes and the inference that at some early period the Anglo-Saxons had been totemists is almost irresistible.

The suffix *atte,* as implying residence, if not possession, crept in, and thereby arose such names as Atte Bourne, Atte Brigg, Atte Hash, Atte Hay, Atte Kirkstile, Atte Lane, Atte Maydens, Atte Stile, Atte Well; the modern names Atwater, Atwood and Atwell occur to us today. The *de* and *atte* were often dropped, hence arose names like Wood, Lane, Briggs. Many names that seem to defy all explanation are disguised beyond recognition; as, who would expect to find Sevenoaks in Snooks; Saint Olave's street in Tooley street; Saint Etheldreda in Tawdry; Douglas in Diggles; Wilburgham in Wilbraham; Tuberville in Troublefield; Longueville in Longfellow; Longchamps in Longshanks; Blondeville in Blomfield; Adburgham in Abraham and Abram; Renshaw in Wrencher and Wrinch; Wymondham in Wyndham. As Mr. Lower truly says: «Corruptions which many family names have undergone tend to baffle alike the genealogical and etymological inquirer.» The name of Shakespeare has had at least 27 permutations in old documents; Goodwin, 17; Finnimore or Phillimore 59 and 34 of the latter surname.

When the country became settled under Edward the Confessor and the Norseman, Saxon and Welshman lived together under a semblance of law and order, official names arose: as Lagman (lawgiver), Fawcett (forseti, judge), Alderman, Reeve, Sheriff, Tabberer, Chamberlain, Chancellor, Chaplain, Clerk, Deacon, Beadle, Latimer (Latinarius, an interpreter), Miles (miles, a soldier), Marshall, Sumner (a summoner, as Chaucer's «Sompnoure»), Parker (a park-keeper), Franklin (a freeholder), Botiler (butler). Trade names and craft names are of later origin; but it is an open question whether some of the names popularly ascribed to occupations will not bear different interpretation.

Because America is a country made up of all nations there exists in the United States a greater variety of names than anywhere else on the globe. Russian, Polish and middle European names seem particularly hard for the American to grasp, and, therefore, immigrants, finding their long names a handicap, are apt to shorten them. Tolchinsky becomes Tolins, and Rawitzer is shortened to Rawser. There is also a tendency to translate names. Herr Vogel becomes Mr. Bird, and Mons. Pantoflen is Mr. Slipper. One is amazed at the combinations disclosed in any large city directory, as in the firms of Au and Magenheimer, Stretch and Shrink, and the famous Call and Tuttle, Preserved Hoskins, Singular Onions Gallyhawk and Esa Hogg must each and all bear grudges against those who inflicted such names on them. It is a fact that all three of these names have appeared in city directories.

Consult Lower, 'Patronymica Britannica'; Bardsley's 'English Surnames'; Wagner's 'Names and their Meaning'; Mordacque's 'History of Names'; Barber's 'British Family Names'; Grant Allen's 'Anglo-Saxon Britain'; and 'Origines Genealogicæ,' by Stacey Grimaldi.

SURPLICE, a garment of white linen, sometimes adorned with lace, worn over the cassock by priests, choristers and other attendants in the chancel during the divine service and by ministers in the solemn administration of the sacraments. It is usually a loose, flowing garment, varying in length: in the 12th century it reached to the ankles and this length was prescribed by the Council of Basel (15th century); in the Anglican Church the surplice reaches almost to the feet. In the Roman Catholic Church its length is much less, never extending below the knees, while in the Italian fashion it does not reach nearly so far and is known as the cotta. See COSTUME, ECCLESIASTICAL.

SURRA, a disease of domestic cattle in the Philippines, due to the presence in the system of a protozoan parasite.

SURRENDER, *in law,* the restoring or giving up, as an estate for years, to the reversioner or remainderman, by which act the surrendered estate is merged in the other; also, the written instrument evidencing such surrender. It should be distinguished from a release, which is an alienation of the estate by the reversioner or remainderman to the tenant. It should also be distinguished from a renunciaction, which is the refusal to take an estate to which one is entitled by law. A surrender by agreement must be in writing, but it may take place by operation of law, as where a landlord accepts another person as tenant.

SURREY, sŭr'ĭ, **Henry Howard,** English poet: b. about 1517; d. 21 Jan. 1547. He was the grandson of the Earl of Surrey who was the victor at Flodden, and who, as a reward for his services, was created Duke of Norfolk. He succeeded to the courtesy title of Earl of Surrey when his father became third Duke of Norfolk of the Howard house in 1524. Surrey became companion to the Duke of Richmond, a natural son of Henry VIII, and in 1533 traveled with him to the French court. He took part in the suppression of the Pilgrimage of Grace in 1536 and in the following year was imprisoned for striking a courtier who had repeated a rumor of his sympathy with the rebels. He served in the army on the Continent and in 1545 was appointed commander of Boulogne, but he was shortly afterward defeated by the French and superseded in his command. Shortly before Henry's death Surrey and his father were suspected of aiming at the throne and were arrested and lodged in the Tower and Surrey was tried, condemned and executed. In 1538 there was published his translation of the second and fourth books of Virgil's 'Æneid,' the first attempt at blank verse in English. He also wrote many sonnets after the Italian model. There is an edition of his works in the 'Arber Reprints.' Consult Hales, J. W., 'Folia Literaria' (London 1893).

SURREY, a kind of light carriage having two seats in a box mounted on side bars, four wheels and sometimes a top.

SURROGATE, formerly a deputy, a substitute, a delegate, a person appointed to act for another. In the United States, an officer who presides over the probate of wills and testaments and the settlement of estates. In English law, one appointed by a bishop or his chancellor or by an ecclesiastical judge, to issue licenses for marriages without bans and to deal with probate and kindred matters.

SURROGATES' COURTS. See COURT.

SURTEES, sėr'tēz, **Robert**, English author: b. Durham, 1 April 1779; d. 11 Feb. 1834. He was graduated from Oxford in 1803 and studied law at the Middle Temple till he inherited an estate near Bishop Auckland in 1802. Thenceforth he devoted himself to preparing a 'History and Antiquities of the County Palatine of Durham' (1816–23), to the fourth volume (1840) of which, completed by Raine, a 'Memoir' of Surtees is prefixed. The Surtees Society, founded in 1834 for editing unpublished manuscripts chiefly relating to the northern counties of England, published its 73d volume in 1884. Consult Taylor, G., 'Life of Surtees' (Durham 1852).

SURVEYING, the science of determining accurately the relative locations of points and lines on the earth's surface and of recording the same on maps; it includes also the reverse operation of discovering and locating on the ground points and lines depicted on a surveyor's map.

Two principal kinds of surveying are recognized, plane and geodetic. In plane surveying the area which is the subject of survey is regarded as a plane surface, the curvature of the earth being disregarded. In geodetic surveying, which deals with areas of large extent, the curvature of the earth is considered and given its proper circumstance.

Plane surveying consists essentially of the lineal measurement of lines and the spacial measurement of angles, either vertical or horizontal; together with the subsequent calculation of the content of areas to which such lines and angles appertain. It includes as classes (1) land surveys — the defining of the boundaries of land areas; (2) topographical surveys — the determining of variations in altitude and the denotation of physical characteristics; as, for instance, roads, rivers, forests, swamps, etc.; (3) construction surveys — the staking out of bridges, buildings, sewers, railways, etc. As the earliest records of man refer to skilful measurements and calculations, it is impossible to assign the birth of the science of surveying to any particular year or even century. Foreip states that, according to the Chaldæans, 4,000 camel steps make one mile, 66⅔ miles one degree, from which the circumference of the earth is 24,000 miles. A papyrus in the British Museum, written 1700 B.C., gives rules for calculating the areas of triangles, trapezoids and circles and the works of Hero of Alexandria (285 B.C.) mention mine surveying and the relatively crude instruments used at that time. In 1617 Snellius, in Holland, made one of the first attempts to determine accurately the earth's radius. Picard, in 1667, adapted cross-wires to a telescope. In 1735 the French Academy of Scientists sent out two surveying expeditions, one to Peru and one to Lapland. The latter resulted in the first demonstration that the earth is not a sphere but an oblate spheroid. The invention of the vernier by Venierus in 1631 and of the transit by Roemer in 1672 gave an impetus to the science of surveying, the final results of which are yet to be achieved.

Chain Surveying.—A great variety of work can be done by the use of a chain or tape alone, as, with the measuring of straight lines, the areas of triangles, rectangles and even polygons can be ascertained by dividing the polygon into triangles which are then measured. Angles can be ascertained by laying off equal lengths, b, from the vertex, A, on the two lines, then measuring the third side, a (base of isosceles), and using either of the following formulæ:

$$\text{Tan } \tfrac{1}{2} A = \frac{a}{\sqrt{4b^2 - a^2}} \text{ or Sine } \frac{A}{2} = \frac{a}{2b}.$$

The angle may then be looked up in a table of sines and tangents. The measurement of inaccessible lines can also be accomplished with the use of only an accurate tape line, as shown in the accompanying Fig. 1. Assume CB to represent the distance to be determined. Lay out from C a perpendicular line (CD) to the point D, from which also the point B is visible; and from D lay DC off DC perpendicular to DB, cutting the extension of the line BC at E. There are then the two similar triangles whose corresponding sides are proportional; and we have the proportion — DC:CB::CE:DC — from which we find $CB = \frac{DC^2}{CE}$. It remains only to measure DC and CE with the closest accuracy possible and to substitute their values in the proportion. The laying of the perpendicular is a simple application of the *pons asinorum* of the geometry — "The square of the hypothenuse of a right-angled triangle is equal to the sum of the squares on the other two sides." In surveying practice this becomes the striking of two curves from the points X and Y respectively, these two points being eight feet apart. The radius of the curve from X is to be six feet, and that from Y 10 feet. The point Z where these curves intersect will be in a perpendicular to XY from the point X, the angle YXZ being a right angle. But such measurements are not comparable with work done with the aid of the transit.

Compass Surveying.— The use of the azimuth compass is considerably restricted for several reasons, namely: The magnetic needle points north at but few places on the earth, the disagreement varying from 1° to 50° from true north. This disagreement, or the angle between true north and the magnetic needle, is called the "declination of the needle." The declination does not remain constant, however, there being diurnal, annual and local variations from the normal declination which introduce unknown errors into the compass survey. The diurnal variation is usually not more than 6 minutes but may reach 20 minutes. It is usually zero at 11 o'clock A.M.; the annual, 1 to 2 minutes, and the local variation amounts to as much as several degrees in some localities, owing to deposits of iron ore near the surface. Errors from this source may be avoided by back sights at each station. There are also secular variations in the declination, so that when retracing the lines of a compass survey made several years previously, the surveyor must use the same declination used in the original survey. In making a compass survey it is necessary to determine the declination of the needle by an observation on a polar star, or on the sun with the aid of a solar attachment (see below). The stellar observation is usually made on Polaris which, however, is not precisely at the north pole. It is necessary, therefore, to make the observation exactly at the time of upper or lower culmination, or at eastern or western elongation; a correction being required in the later case. Tables have been published, however, by the United States Land Office for taking the observations on Polaris at any convenient time.

where surveyed correctly — hence the necessity for correction lines every 24 miles as noted above. The distances between the meridians at certain latitudes are in proportion to the cosines of the respective latitudes concerned.

There are several methods of surveying north and south boundary lines of townships and sections so as to make them conform to a parallel of latitude, but the secant method is the one commonly employed (Fig. 4). Briefly stated it is as follows: A straight line, for convenience called a secant, is run upon a certain course, precisely calculated (nearly due west), and dependent upon the latitude, and from such a point as will cause it to intersect the curve of the parallel of latitude (boundary line) at the mile and five mile points. From this secant line offsets, as previously calculated, are measured north or south as required at the mile and half mile points, to points in the curve or boundary line where monuments are placed. Convenient tables are published by the United States Land Office which show the azimuths and offsets required at any latitude in the United States.

COURSE	Bearing	Distance	North Lat.	South Lat.	East Dep.	West Dep.	L. O.	D. O.	D. M. D.	N. Area	S. Area
1—2.....	N48° 17′E	400.00	266.18	......	298.58	......	65.10	000.00	298.58	79476.02	....
2—3.....	S30° 42′E	150.00	......	128.98	76.58	......	331.28	298.58	673.74	....	86899.00
3—4.....	S20° 5′W	140.00	......	131.49	......	48.07	202.30	375.16	702.25	....	92339.00
4—5.....	S72° 53′E	75.00	......	22.07	71.68	......	70.81	327.09	725.86	....	16019.73
5—6.....	S80° 39′W	300.00	......	48.74	......	269.01	48.74	398.71	501.53	....	24444.57
6—1.....	N57° 39′W	121.66	65.10	......	......	102.76	000.00	102.76	102.76	6689.68	....
										86165.70	219702.30
											86165.70
										2)	133536.60
										43560.)	66768.30
											1.53 A.

Government Land Surveying.— The first public surveys in the United States were made in the State of Ohio under an ordinance of the Continental Congress passed 20 May 1785. This ordinance was slightly modified by an act of Congress, passed 18 May 1796. This act, which is still in force, provided that all public land, except certain private land grants shall be divided into townships six miles square, and that sections shall be subdivided into one-fourth sections one-half mile square. The act further provides that all lines of public land surveys shall be run on either true meridians or true parallels of latitude. The method of surveying townships and sections is as follows: *First* — In each State, or convenient group of States, there is established a principle (true) meridian, and, at right angles thereto, a base line conforming to a true parallel of latitude. *Second* — Standard parallels or correction lines, also conforming to parallels of latitude, are established at intervals of 24 miles north and south of the base line. *Third*— Guide meridians conforming to true meridians are initiated at intervals of 24 miles along all standard parallels, and run due north to the intersection of the next standard parallel. *Fourth* — The rectangles thus formed by the guide meridians and standard parallels are subdivided into 16 townships. As meridians converge toward the north pole the north boundary lines of townships are less than six miles long

Traversing.— This is a method of surveying a polygon by surveying its perimeter only, as distinguished from the method of cutting the polygon up into triangles (Fig. 5). In a

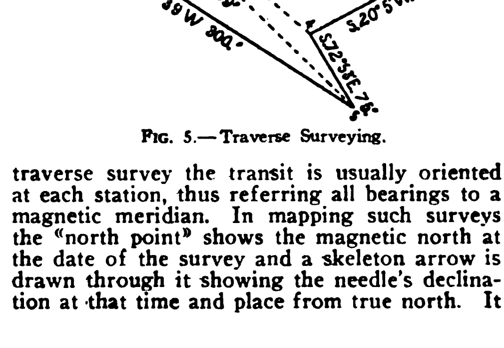

Fig. 5.— Traverse Surveying.

traverse survey the transit is usually oriented at each station, thus referring all bearings to a magnetic meridian. In mapping such surveys the «north point» shows the magnetic north at the date of the survey and a skeleton arrow is drawn through it showing the needle's declination at that time and place from true north. It is not necessary to take convergence of the meridians into account except in geodetic work. The method of procedure is as follows: The transit is set up at station No. 1 and the bearing and distance of the first course determined. The transit is then removed to station No. 2. With vernier "A" still at the previous reading, the lower spindle is unclamped and a plumbed rod bisected at station No. 1, ***with the telescope inverted***. The telescope is then revolved to its normal position, unclamped, and the bearing and distance to station No. 3 ascertained. The transit is then removed to station No. 3 and the operations repeated. To illustrate this important branch of surveying the tabling of a traverse and the rules governing the same are given in the table on the preceding page.

In the foregoing "tabling" the latitude and departure of each course is found by multiplying the distance by the cosine and sine of the angle expressed by the bearing. The latitude and departure ordinates are self-explanatory. The single meridian distances are the departures of the respective stations from the most westerly station. The double meridian distances of the respective courses are equal to the sum of the single meridian distances of the stations at each end of the respective courses. Each North and South area is equal to the product of the latitude of a course into its corresponding double meridian distance. The area of any polygon is equal to one-half the difference between the sum of the North and South areas. When the course and distance of any side of any polygon is lacking it is found as follows: Ascertain the difference between the north and south latitudes and the difference between the east and west departures. Divide the difference in departures by the difference in latitudes for the tangent of the bearing. Divide the difference in departures by the sine of the bearing found, for the distance.

Topographical Surveying.— In order to facilitate the selection of a route for a railroad, to properly locate an irrigation reservoir or dam for power purposes, or to correctly make a geological survey of a large tract it is generally necessary to make a topographical survey of the area under consideration. From the field notes of the survey a map is made showing the surface elevations with considerable particularity by a system of contour lines at stated differences in level, and also showing all important objects, such as buildings, roads, canals, fences, streams, etc. There are several methods of making a topographical survey. First, by the use of a tape, level and transit. Second, by the use of the plane-table. Third, by the use of a transit and stadia rod. The last-named method alone will be discussed here, it being the method usually adopted, on account of its celerity and low cost. Stadia wires are two horizontal wires placed in an adjustable ring so that they appear at equal distances above and below the horizontal cross-wire when looking through the telescope.

The theory of stadia measurements is based on the two following equations:

$$1.\quad i : o :: f_1 : f_2$$

$$2.\quad \frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{f}$$

in which "i" is the height of image or distance between the stadia wires, "o" the height of object or the stadia reading on the rod, "f_1" the distance from the lens to the image, "f_2" the distance from lens to the object and "f" the focal length of the lens. From the above equations and other considerations it can be shown that when the rod is held vertical at various points in the line of sight, the rod readings will be proportional to the respective distances from the rod to a point at a distance "f" in front of the lens of the telescope. It can also be shown that the distance from the stadia rod to the centre of the transit is equal to the sum of three factors, namely, the rod reading, the distance "f," and the distance from the lens to the centre of the transit, "c." But this is true only for horizontal sights, for when the rod is held upon an elevation, as a hill, then "f_2" becomes the slope distance and, moreover, the stadia wires will intercept a length on the rod greater than the slope distance. Therefore, if the stadia wires be adjusted so that they will intercept a space of one foot on the rod at a horizontal distance equal to c + f + 100 feet from the centre of the transit, then the true horizontal distance to any point above or below the horizontal line will be found by the following equation:

$$3.\quad D = 100\ r \cos^2 v + (c + f) \cos v.$$

In which

D = true distance horizontally.
v = vertical angle.
c = centre of transit to object lens.
f = focal length of lens.

The height is found by multiplying the horizontal distance by the sine of the vertical angle. Tables are published containing the factors for the various vertical angles.

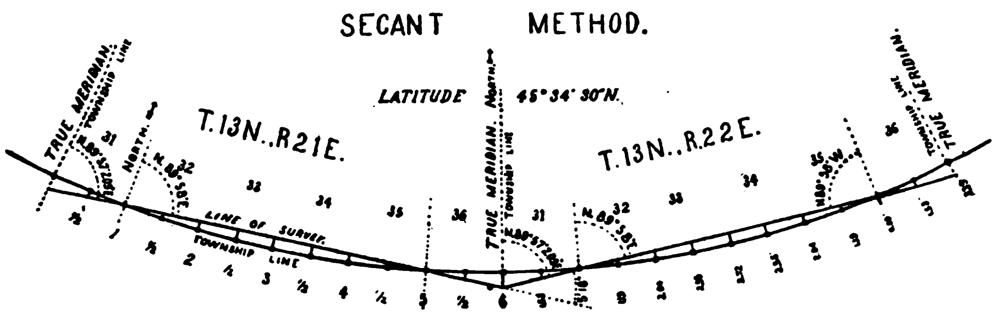

Fig. 4.—Land Surveying Secant Method.

In topographical field work where the area to be surveyed is considerable it is usual to first lay out a triangulation net work, all measurements being made with a tape or by triangulation from an accurately measured base line and the stadia measurements taken from the triangulation stations. In work of less magnitude it is not necessary to lay out a system of triangles, but all measurements from station to station are carefully made and checked by cross-readings. The location of objects is quickly and accurately accomplished by sights from two different points of the measured line. In making a map of a topographical survey there are several methods employed. One requires the use of a T-square and brass protractor, another and a better method is by the use of a protractor sheet larger than the sheet upon which the drawing is to be made. After all distances are laid off and the heights indicated at the various points, contour lines are drawn in by proportioning the distance between points with reference to heights. Sometimes the contour lines are drawn in pencil to be afterward erased and the «hatchure» method of representing topography employed.

Mines Surveying.— The chief purposes of an underground survey are to ascertain the amount of ore «in sight,» to find the «pitch» and position of the «pay chute» with respect to the shaft and levels, to find the «dip» of the vein and also to ascertain and lay out the direction of connections commonly called «holings.» Moreover the laws of some States and countries require plans of the underground workings to be kept on file. Ventilation being one of the serious problems in mining — especially coal mining — it is generally necessary to make passageways or «holings» connecting the various drifts and levels in such a way as to facilitate the circulation of fresh air throughout the mine. In order to make these connections a careful transit survey is necessary, the compass needle being unreliable in the presence of pipes, rails, ore cars, etc. While mine surveying does not call for the precision of a geodetic survey, cases arise requiring great skill and ingenuity. One of the chief difficulties is to transfer the bearing or azimuth of a surface line to the lower workings. This is especially difficult if the survey has to be carried down a deep vertical or inclined shaft. In vertical shafts heavy plumb-bobs suspended in pails of water or molasses at the bottom of the shaft by means of wires reaching to the surface have been successfully used. A transit with a secondary telescope, so attached to the extended axis of the primary telescope that it may be sighted vertically downward, is also used for this purpose. In underground work it is necessary to note both vertical and horizontal angles and to make tape measurements on the slope or level as the circumstances may permit. Illuminated plumb-lines are used for fore and back sights and it is also necessary to hold a candle so as to illuminate the telescope cross-wires. Permanent pegs for future use are usually placed in the roof instead of in the floor of a drift and even then their position must be often checked for ground moves considerably in some mines.

Geodesy.— This branch of surveying has for its object the exact location of points and lines with reference to the true form of the earth. In most geodetic work the earth is assumed to be an oblate spheroid, all measured angles and distances being reduced to spheroidal angles and distances. The United States Coast and Geodetic Survey had adopted the «Clarks spheroid of 1866.» The foundation of a geodetic survey is a base line. This is most carefully measured with specially constructed bars of invar steel (q.v.) encased in wood, called a «Base line apparatus.» Base lines can be measured with steel tapes with an accuracy of one in 1,000,000 under favorable circumstances. These tapes have a screw adjustment for temperature as shown by a thermometer in the handle and there is also a helical spring attachment for regulating exactly the pull used in stretching the tape. Two tapes are used in each measurement and, in case of disagreement are compared with a third and fourth tape. An accuracy of one in 300,000 is generally accepted as satisfactory. With a base line as a nucleus, a system of triangles is laid out over the surrounding country, additional base lines being measured from time to time to serve as a check upon the work. In a primary triangulation the sides of the triangles are very long — 20 to 100 miles. The first series of triangles laid from the base line are as nearly equilateral as they can be made. This conduces to accuracy in the larger triangles. Within the primary triangles secondary and tertiary triangles are laid out, the lines of which are from 1 to 20 miles in length. Angles are measured with specially constructed transits, average results of several readings by the «continuous reading» method being necessary. The unknown sides and angles of the spheroidal triangles are calculated and, when possible, the angles are checked by actual observation. Vertical angles are also read at each station and corrected for refraction and curvature of the earth. The permissible error in a primary triangulation by the United States Coast and Geodetic Survey is one-fourth inch per mile or one in about 250,000; the permissible error in the measurement of an angle is three-tenths of a second and the closing error must not exceed five seconds, or one in about 260,000. As it is impossible to measure angles with absolute accuracy it is necessary to adjust the angular measurement by a system of averaging errors. In determining the azimuth of any geodetic line the convergence of the meridians has also to be taken into account.

Hydrographic Surveying.— This includes surveys for determining the depths of water in rivers, bays and harbors for purposes of navigation; the determination of velocity and direction of currents; the location of hidden rocks or shoals and buoys, lights, etc.; and the determination of the amount of silt or sediment carried by streams and deposited in bays. Permanent bench-marks and stations are generally made on shore, and the points at which soundings are taken located by triangulation. There are several methods of locating sounding points. First, an observer with a transit is stationed at each end of a base line. At the instant the man on the water makes a sounding he signals the two transitmen to take their observations for azimuth. Second, by the «three point problem.» That is, by reading from the boat two angles to three points on shore whose relative positions are known. Of course, sextants only can be used for measuring angles from the boat.

Soundings are taken in feet or fathoms, the mean water level being taken as the datum plane. For tide waters the average sea-level is ascertained by means of a tide-gauge. In some cases automatic tide-gauges are kept in operation for one or more years to determine an average sea-level.

The velocity of water currents in large streams is ascertained by means of a current metre, several styles being in use. The flow of the water in small streams is best determined by means of a weir.

Photographic Surveying.— The use of the camera in surveying is comparatively recent and, though its use is restricted in many ways, it has come into quite general use. It may be called a successful rival to the plane-table. Photo-surveying has been used with success in Italy, India, France, United States and Canada. In the latter country it has supplanted the plane-table almost entirely.

The advantages of a photo-transit are that with it more rapid and cheaper work can be done than by any other means. The results, however, are not as satisfactory as with the plane-table. The photo-topographer must have a thorough knowledge of perspective drawing, descriptive geometry and photography. The instrument used consists of a compass or a horizontal, graduated plate with a vernier, to which is attached a camera having a sensitive level and a means of very accurately measuring the focal length at the time each view is taken. If a box camera having a universal lens is used this latter requirement is not necessary. There is also attached to the top or side of the camera a telescope having stadia wires and a vertical circle. Some styles have a scale so placed in the box that it is photographed on the plate when the view is taken. In any case four projecting needles or two cross-wires are so placed in the box that they will indicate the horizon and line of sight in the developed negative. The stadia rod is also photographed as a part of the record. The topographical map is drawn in accordance with the principles of perspective drawing and descriptive geometry, from measurements taken from the photograph, the compass bearing and stadia measurements being taken into account.

Plane-table Surveying.— A plane-table consists essentially of a drawing board mounted upon a tripod together with an alidade, an alidade being a graduated ruler carrying a telescope. (Fig. 3). A graduated vertical circle for measuring vertical angles is attached to the telescope, and stadia wires for measuring distances are often inserted in it. In operation, the drawing board is covered with a sheet of drawing paper and the alidade telescope sighted consecutively to the various objects which are to be represented in the drawing, pencil lines being drawn upon the paper along the edge of the ruler at each sighting. The plane-table is then set up over another station whose relative position has been fixed by survey with respect to the first station, and sights taken to all the points sighted from the first station. The pencil lines will intersect at the points which represent the respective objects. Stadia readings are often taken with the alidade telescope, the true elevation and horizontal distances being taken from a slide rule constructed for that purpose. The plane-table is much used by the United States Coast Survey and the United States Geological Survey, as more topographical work can be done in less time by its use than by any other means except photo-topography. Errors in azimuth are impossible and more complete work can be done by making the drawing in the field than by plotting from field notes in the office.

Railroad Surveying.— Railroad surveys are either preliminary, for the study of the terrain, or for the purpose of actual location. A preliminary survey is often nothing more than a topographical survey of a comparatively wide strip of country through which it is expected to run the line, a paper location being made in the office and the location survey of the paper location afterward made upon the ground. While a topographical survey gives little or no information regarding cuts and fills it is of great value in deciding upon the most advantageous location.

Briefly stated a railroad location survey consists of a survey of curves, the tangents joining them and the grades. Tangents and curves are laid out with a transit, the grades and cross-sections being worked out with a level. From the cross-section field notes the cubic yards of earth or rock in the cuts and the volume of the fills is computed in the office. The grade line is so located that the material taken from cuts will furnish enough material to make the fills. All straight portions of a railroad are called «tangents,» and the curves are surveyed as the sides of an inscribed polygon of equal sides, each side being 100 feet. (Fig. 6). The «degree of curve,» D, is the angle at the centre

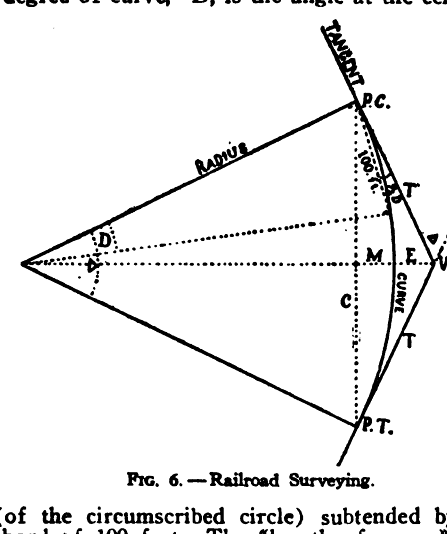

FIG. 6.—Railroad Surveying.

(of the circumscribed circle) subtended by a chord of 100 feet. The «length of curve,» L, is the sum of the sides of the inscribed polygon. The «central angle,» Δ_1 is the angle at the centre included between the radii which pass through the tangent points. It is equal to the external angle of the polygon, that is, the deflection angle of the tangents. The «tangent distance,» T, is the distance from the vertex to either tangent point. The conditions are such that in any simple railroad curve:

1. $\sin {}^1/_2 D = \frac{50}{R}$ 4. $\sin {}^1/_2 d = \frac{C}{100} \sin {}^1/_2 D$

2. $T = R \tan {}^1/_2 \Delta$ 5. $R = T \cot {}^1/_2 \Delta$

3. $L = 100 - \frac{\Delta}{D}$

By means of the above and other formulæ all the elements of a railroad curve can be computed. Where tracks are to be laid especially for trains of certain speed it is the practice to lay out compound curves approaching closely the parabola, in order to make a more gradual transition from tangent to curve. When passenger and freight trains run upon separate parallel lines the outer rail of the passenger line is made higher than the outer rail of the freight line, to better counter the higher centrifugal force at the greater speed. There are several methods of surveying a railroad curve: by tangent offsets, by ordinates from a long chord, by middle ordinates, by offsets from chords produced and by deflection angles. Circumstances determine the method to be used. Tables are published giving the formulæ and other information needed by the railroad surveyor.

Leveling.— Ordinary leveling is usually done with either a «Dumpy» or a «Y» level, the latter being favored by American engineers. The superiority of the «Y» level is due to its construction, which permits the telescope to be reversed in the Y's. Some levels have stadia wires inserted for reading distances and in some cases these are so placed that they can be thrown out of focus by revolving the eye piece, thus making it impossible to make an error by reading a stadia wire instead of the central cross-wire. In order to increase the clearness and sharpness of vision, levels are often rendered «inverting» by omitting one lens. Ordinary level rods are made to telescope — that is, lengthen or shorten — and are usually graduated into feet, tenths and hundredths of feet, but they can be read to thousandths of a foot by the aid of a vernier attached to the target. In precise leveling three methods are practised by the United States government, depending upon the instruments used. The United States engineers employ the «Kern» level and a «speaking» rod, the United States Coast and Geodetic Survey employs a peculiar instrument called a Geodesic level, which requires lengthy and expensive computations. The United States Geological Survey employs a modification of the ordinary Y level and either «speaking» or target rods. In precise leveling the fore and back sights must be taken at the same distance, otherwise a correction for curvature of the earth must be applied. One method of checking a line of levels is to level back over the same line of pegs. Another and a better check method is to employ two rods and two rodmen with one levelman, two independent lines of turning points being run. Precise level rods are usually non-telescopic, that is, made in one piece, and the wood is heated and then paraffined. Graduations are sometimes on strips of metal countersunk into the wood. The limit of permissible error of the United States Coast and Geodetic Survey is $.02 \times \sqrt{\text{distance in miles}}$, the product expressed in feet.

Solar Attachment.— This is an instrument which may be attached to a compass or transit to aid in determining the meridian, latitude and time by observations made on the sun. There are various forms manufactured, the Burt and the Smith being those most extensively in use. The solar is usually secured to the transit telescope and it is used at any time of day, the early morning, late evening and noon hours being avoided for reasons too lengthy to be explained here.

In order to determine the true meridian from the sun it is necessary to ascertain the declination of the sun at the time of observation. A solar ephemeris or nautical almanac will give the sun's declination at noon at Greenwich, England, for each day of the year. The surveyor must correct this declination for longitude (q.v.), hours from noon, and refraction before making the observation. The refraction correction varies with the latitude (q.v.), hours from noon and declination of the sun. Having found the declination of the needle, the compass-box is moved so as to bring the needle at N. and S. in which case it will indicate true bearings.

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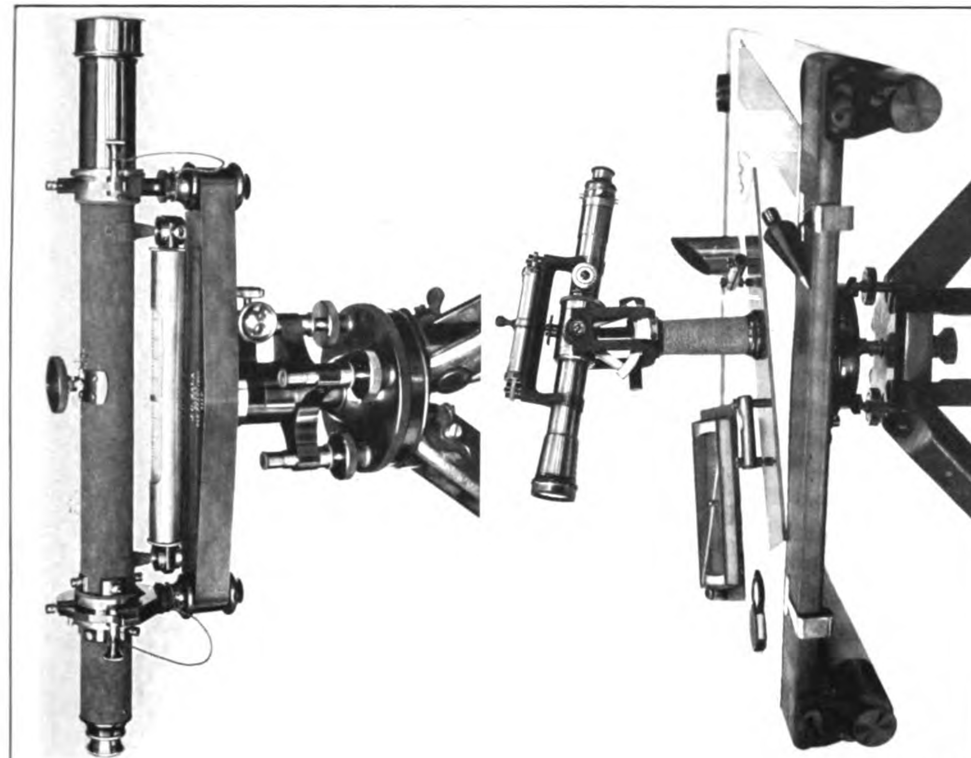
O. H. PACKER,
Mining Engineer, San Francisco, Cal.
Revised by RICHARD FERRIS.

SURVEYING, Marine. See SURVEYING.

SURVEYING INSTRUMENTS. The instruments used in the business of surveying fall into two general classes: those used in the field work and those used in recording the field work on maps. In both classes there are three objects to be attained, and suitable instruments are provided for each — the marking of points, the measurement of lines and the measurement of angles.

In field work the «pin» is the instrument used for the temporary location of a point. It is made of stout iron wire, or slender steel wire, about eight inches long, and with a ring turned at the top. Ten pins go in a «set.» In field use it is customary to tie a bit of red flannel rag in the ring of the pin, so that it may be found quickly by the chainman. If the point is one which is to be marked permanently, the pin is replaced by a wooden «hub» with a copper nail, or with a

SURVEYING INSTRUMENTS



1 Transit, with Saegmuller Solar attachment

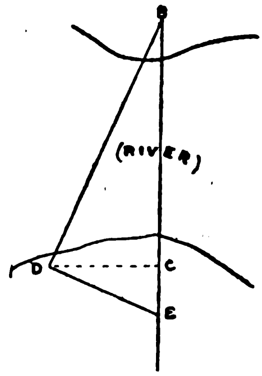
2 Y-Level

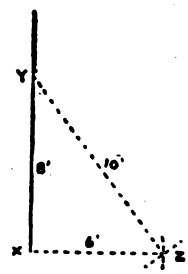
3 Plane Table

stone monument marked with a simple cross cut into the stone, or a bronze bolt may be set into a hole drilled in the top of the monument.

For making linear measurements a long-recognized standard has been the surveyor's or Gunter's chain. It is 66 feet in length, made up of 100 links of stiff iron wire or steel, with a ring-shaped loop at each end, the adjacent links being connected by two rings. Each measured link is 7.92 inches long, including the span of a connecting ring at each end. This chain is still in use for retracing the lines of old surveys in which it was originally used, particularly in the resurvey of government public lands. The more modern engineer's chain is 100 feet long, and has 100 links; each, with its two adjacent rings, comprising one foot. Both of these types of chains are comparatively rude instruments, and for close work have been supplanted by the narrow steel ribbon or tape, which, however, in surveyors' parlance goes by the name of «chain.» This is a continuous strip of steel, one-eighth to three-sixteenths of an inch in width and one-fortieth to one-thirtieth of an inch in thickness. It may be 50 feet or 100 feet in length. Ten-foot divisions are marked by small blocks of brass soldered upon the steel, the exact points being indicated by notches filed in the brass. These ribbons are generally provided with a compensating handle for the forward end of the «chain.» This handle is of two sections of brass tubing, one of which contains a thermometer and an adjustable scale, so that the length of the «chain» may be made longer or shorter according to the reading of the thermometer — the «chain» having been tested according to a given temperature. The other section of the handle contains a spirit level, to ensure that the measurement is strictly horizontal; and a stout helical spring which must be drawn out to an index mark, and thus ensures that in every measurement the same degree of tension is exerted upon the «chain.» This type of chain cannot be bundled up as with the link type, and a folding reel is provided upon which it is safely carried about. For short and precise measurements the steel tapeline is employed. This is a ribbon of steel about half an inch in width and one-eightieth to one-hundredth of an inch in thickness. It is graduated in feet, tenths and hundredths of a foot, so etched upon the steel that the divisions appear in relief. This type of tape line rolls up by means of a cranked handle into a leather case. Linen tapes and combination tapes of linen and brass wire are useful in some instances, but cannot be depended upon where accuracy is important. Tapes and ribbon «chains» may be authoritatively tested if sent to the Superintendent of the United States Coast Survey at Washington. Measurements of extreme accuracy, as in the establishment of a base line for triangulation, are made with «base bars» or «compensation bars» so constructed of iron and brass that they remain the same length regardless of changes in temperature. These bars are carried about in cases of wood, and are used in sets of six, being each supported on two stout tripods. Another form of base bar is provided with a trough in which is kept continually while in use a mixture of ice-water and ice — thus ensuring a constant temperature of 32°, to which the bars are standardized. The steel alloy known as «invar» (q.v.) is also used with entire satisfaction within a certain range of temperatures, in which the metal does not expand in length. For measuring small vertical distances, as in leveling, a telescoping rod is used. The type most in use is known as the New York Leveling Rod. This rod is of maple, about two inches square and nearly seven feet in length, and has a brass shoe and a brass cap. The face of the rod is graduated into feet, tenths and hundredths of a foot, up to 6.50 feet. A sliding target of oval outline has its centre cut away so that the graduations of the rod are visible. On one of the inner edges of the target a vernier is provided so that thousandths of a foot may be read. The rod is made in two longitudinal sections dovetailed together, the back section sliding upon the front. When a vertical distance of more than 6.50 feet is to be measured, the target is clamped at that figure, a lower clamp loosened and the back part of the rod raised upward until the target comes into line. The reading now is taken on the side of the rod, which also is graduated, so that distances up to 12 feet may be measured to the thousandth of a foot. To ensure the verticality of the rod in the hands of the rodman, when measurements are being made, the target is sometimes constructed with two target faces, one three or four inches back of the other, the ends of the front face being cut away, so that a yiew of both discs is had at once. Any deviation from a vertical position is immediately noticed through the lack of agreement of the horizontal line of both discs. There are several other forms of leveling rods, but in the United States the New York rod is almost universally in use. «Speaking rods» are those which are so painted as to be easily read by the observer at the instrument, without dependence upon the rodman. This type is exceptionally useful in rapid reconnaissance work, where long sights are taken. They are not so accurate, however, as the target rod when it is carefully used. The type most in favor is the Philadelphia rod, in which the graduation is in figures six one-hundredths of an inch in height, set with their centres on the lines marking the tenths of the foot. It is quite easy for the leveler to estimate the hundredths of a foot with great accuracy, but impossible to read to thousandths.

The level is obviously an essential instrument in using the leveling rod, to mark the upper limit of the vertical distances measured upon the latter. It consists of a telescope, 20 inches in length, in which the line of sight is carried by the intersection of cross-hairs, and to which is attached a «bubble tube» of glass filled with a mixture of ether and alcohol except for the long bubble of air. This tube is about eight inches long and three-fourths of an inch in diameter, and is curved to a long radius, the convexity of the curve being set uppermost. Upon this face of the tube is a centre line and graduations on either side of it. The tube is so attached to the telescope that it may be adjusted and brought accurately parallel to the line of sight through the telescope. The combination of bubble tube and telescope is reversible in its Y-shaped bearings, from which it is called a Y-level; and is mounted upon a frame with a long conical spindle held by a pair of plates between which are four leveling screws, the whole being attached to a tripod, as shown in the accompanying illustration. A pair of stadia wires is often added to the cross-hairs of the telescope, so that the distance of the leveling rod may be computed by taking a second reading, above or below the level line at the time when the level is fixed. An ingenious device renders the stadia wires invisible when the cross-hairs are being used, and vice-versa. A small pocket level known as the «Locke Level,» is of great usefulness in reconnaissance work. In this instrument the bubble tube is attached to





the top of the tiny telescope, the upper part of which is cut away, and a semi-circular mirror at 45 degrees placed beneath it in the telescope. The image of the bubble in the mirror decides when the instrument is held in a true level position, and at the same moment the point at which the level line strikes the leveling rod is in plain view.

For the measurement of angles in the field the commoner instruments are the magnetic compass and the transit. The former depends upon a continual reference of the direction of a line to the magnetic north-and-south line indicated by a magnetic needle swinging in a compass box, the rim of which is graduated to 15 minutes of arc; from which the angle can be very closely estimated to five minutes. By an attachment to the compass it may be made a solar compass, a necessity where the principal lines of the survey are referred to the true meridian, as in government surveys of the public lands. The compass may be still further improved by the addition of a telescope, which may be clamped to the rear sight, and this telescope may have a long bubble tube, making it available for running levels, and it may also carry a vertical circle for measuring vertical angles.

The transit is the engineer's instrument of precision for angular measurements. Its essential factor is the plate, from five to seven inches in diameter, bearing graduations of exquisite accuracy, to 30 minutes of arc in the smaller instruments and 20 minutes in the larger ones. Verniers are affixed at opposite sides of the plate by which the angular measurement may be made to 30 seconds in the one case or to 20 seconds in the other. The telescope which carries the line of sight with the intersection of cross-hairs is often fitted with stadia wires also, so that the tangents of the distances may be measured upon a leveling rod. A long bubble tube enables the engineer to use the transit for all ordinary leveling work. It is not uncommon to have a four-inch vertical circle attached, carried on four arms, and reading to single minutes. A solar attachment, consisting of three arcs of circles, on which the latitude of the place, the declination of the sun and the hour of the day may be set off, converts the instrument into a solar transit. Where a vertical circle is a part of the instrument, this serves for the latitude arc. The transit shown in the illustration is equipped with the popular Saegmuller solar attachment mounted above the primary telescope. A special form of the transit for mining engineers has the axis of the telescope extended beyond the standard at one side, and a second telescope mounted upon it so that a sight may be made directly downward. For very accurate and extended work, as in geodetical work, the telescope of the transit is sometimes 36 inches in length, the horizontal graduated circle 36 inches in diameter and the vertical circle 24 inches in diameter.

The plane table is practically a drawing board, usually 24 by 36 inches. In its simplest form the ruler or «alidade» carries two sights at the ends by which the direction is obtained, the line of this direction being then drawn along the ruler upon a sheet of paper attached to the board. In the better class of instrument the sights are replaced by a telescope, which sometimes carries stadia wires for measuring distances, a compass box for orientation and short vertical arcs for measuring tangents which cannot be covered by the stadia wires. The plane table is of use chiefly for rapidly filling in topographical details upon the may made by ordinary surveying methods. The plane table shown in the accompanying illustration is equipped with reels for carrying a continuous roll of drawing paper. See SURVEYING.

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SURVEYS, United States Governmental. From an early period in its history the government has made provision for exploring expeditions of various kinds, mainly in the vast region west of the Mississippi which for many years was a but little known wilderness. Some of these explorations were for military routes to the west and later came surveys of public lands. The first official surveys were made by a geographer attached to the Continental army in the Revolution and in 1781 Thomas Hutchins (q.v.) was attached to Greene's division (Southern) as geographer. After the Revolution he was retained to supervise surveys of the Western lands and continued in office until his death in 1789.

The earliest governmental explorations in the West could hardly be regarded as surveys although many of them prepared maps which added greatly to knowledge of a little known region. Position were determined astronomically, and route maps were the principal products. The first of these was the Lewis and Clarke expedition sent out by President Jefferson in 1803. One of its products was a map of the country between Lake Superior and the Pacific Ocean between the 39th and 49th parallels. Major Z. M. Pike's expeditions in 1805–07 to the sources of the Mississippi and of the Arkansas and Red rivers were fruitful of geographic results. Major S. H. Long's expedition from Pittsburgh to the Rocky Mountains in 1819 and 1820 was under order of the Secretary of War. In 1823 Long made another journey to the Great Lakes and the source of Saint Peter's River. Sextant and pocket chronometer were used, distances were estimated and courses were taken by compasses. The most elaborate early survey was that of J. C. Brown of a road from Osage to Taos in 1825–27. Chain compass and a good sextant were used and a large scale map prepared. Similar to it are the surveys by R. Richardson of a road from Little Rock to Fort Gibson in 1826, and a survey by Dimmock in 1838 for a military road from Fort Smith to Fort Leavenworth. In 1832 Lieutenant Allen on the Schoolcraft expedition made an excellent map on a scale of 5.75 miles to an inch, of the head of the Mississippi Valley but all the distances were estimated. He was the discoverer of the source of the great river.

The Bonneville expedition in 1832–36 was not under governmental authority although Bonneville was an army officer. The Wilkes expedition in 1841 surveyed part of Columbia River. The first of the early expeditions which could be regarded as a geological survey was made by Featherstonhaugh in 1834 to the Ozark region, The following year his observations were extended along the Couteau des Prairies between the Missouri and Minnesota rivers. In 1838 Nicollet was sent by Colonel Abert of the United States Army Engineers to make a map of the hydrographic basin of the Mississippi River. In 1839 and 1848 D. D. Owen made surveys of mineral lands of the Northwest extending to Lake Superior and covering an area of 57,000 square miles. These surveys were made for the United States Land Office. In 1847–48 C. T. Jackson and J. D. Foster and J. W. Whitney operating under orders of the Secretary of the Treasury extended this work in the copper district of the Lake Superior region.

Corps of Engineers, United States Army. — A large amount of surveying was done by the topographical engineers of the United States army. The first notable expedition under that bureau was N. Nicollet's explorations of the basin of the upper Mississippi River in 1836–40 which resulted in a map which is regarded as a most important contribution of American geography. His surveys were largely instrumental and he used a barometer for ascertaining elevations. The Fremont expedition in 1842 resulted in a valuable map on the millionth scale, of the country from the forks of Platte River to South Pass between the 43d and 45th parallels. Expeditions by Fremont in following years 1843–46 extended his observations westward to the Pacific Ocean and the surveys made were the basis for important new maps.

The following is a list of some of the more notable army expeditions and surveys from 1836 to 1879 (excepting the surveys for Pacific railroads which are noted on following page):

List of Principal Surveys under the Bureau of Topographical Corps of Engineers, United States Army.

1836–40	I. N. Nicollet	Upper Mississippi Basin.
1842	Lieut. J. C. Fremont	Missouri River to Rocky Mountains.
1843–44	Capt. J. C. Fremont	Rocky Mts. and to Oregon and northern California.
1846	Capt. G. W. Hughes	San Antonio to Saltillo, Mexico.
1845	Lieut. J. W. Abert	Between Platte River and 35th Parallel to Rocky Mts.
1846–47	Maj. Wm. H. Emory	Fort Leavenworth, Mo., to San Diego, Cal.
1849	Lieut. G. H. Derby	Part of Sacramento Valley.
1847	Lieut. J. D. Webster	Rio Grande from north of Matamoras.
1849	Lieut. J. H. Simpson	Road from Fort Smith to Santa Fé.
1849	Lieut. J. H. Simpson	Navajo County.
1849–50	Capt. H. Stansbury	Valley of Great Salt Lake.
1849	Capt. John Pope	Red River of the North.
1850	R. H. Kern	Rio Pecos.
1850–51	Capt. Sitgreaves and Lieut. Woodruff	Survey of Creek Boundary.
1851	Capt. Sitgreaves	Down Zuni and Colorado rivers.
1852	Lieut. Derby	Colorado River Mouth to Fort Yama
1852	Capt. R. B. Marcy	To sources of Red River.
1853	Capt. J. H. Reno	Big Sioux to Mendota.
1854	Lieut. G. H. Derby	Oregon and Washington Territories.
1855	Lieut. G. H. Mendell	Snake River.
1855	Lieut. G. K. Warren	Dakota and Sioux County.
1856	Lieut. G. K. Warren	Missouri and Yellowstone rivers.
1857	Lieut. G. K. Warren	Territory of Nebraska and Black Hills.
1857–58	Lieut. J. C. Ives	Colorado River from Fort Yuma to Grand Canyon.
1859	J. N. Macomb	Santa Fé to junction of Green and Grand rivers.
1859	Capt. J. H. Simpson	Great Salt Lake Valley.
1859–60	Capt. W. F. Reynolds	Headwaters of Yellowstone and Missouri rivers.
1859	J. B. Dixon	Route from Fort Dallas, Ore., to Great Salt Lake Valley.
1869	Capt. Chas. W. Raymond	Yukon River Basin.
1869	Lieut. Geo. M. Wheeler	Southern and southeastern Nevada.
1870	Capt. D. P. Heap	Northern Montana and Dakota.
1871	Capts. J. W. Barlow and D. P. Heap	Upper Yellowstone County.
1871	Capt. W. A. Jones	Uintah Mountains.
1873	Capt. Wm. Ludlow	Yellowstone River.
1873	Lieut. E. H. Ruffner	Ute County.
1873	Capt. W. A. Jones	Northwestern Wyoming and Yellowstone Park.
1874	Lieuts. E. H. Ruffner and Anderson	Fort Garland, Colo., to Fort Wingate, N. Mex.
1874	Capt. Wm. Ludlow	Black Hills.
1875	Capt. Wm. Ludlow	Carroll, Mont., to Yellowstone Park.
1876	Capt. W. S. Stanton	Bighorn and Yellowstone Valley.
1877	Capt. W. S. Stanton	Routes in Wyoming.
1869–79	Capt. G. M. Wheeler	Geographical Surveys west of 100th Meridian.

There were also many reconnaissance trips and explorations for roads which can hardly be called surveys. Some of the maps were not published but remain on file in the War Department.

Black Hills Survey.— In 1874 Capt. W. Ludlow made expeditions through the Black Hills of South Dakota with N. H. Winchell as geologist. The results were given in a quarto volume issued in 1875. Later the Indian Bureau sent an expedition under W. P. Jenney and H. E. Newton to investigate reports of gold in these hills and a quarto report with folio of maps was published by the Survey of the Rocky Mountain region.

Pacific Railroads.— In 1853 the War Department began a series of explorations for routes for railroads across the Far West. The expeditions were conducted by army officers but had topographic and geologic assistants, who made surveys of various kinds. Among these geologists were Jules Marcou, Thomas Antisell, J. S. Newberry, W. P. Blake and James Schiel. The routes surveyed were not far from the several transcontinental railroad lines of to-day. The results were published in 13 quarto volumes which contain not only geographic results of the surveys but a large amount of information on natural history, resources, etc.

International Boundaries.—The boundaries of the United States have been surveyed by various organizations. In 1818 surveys were begun on the northern boundaries of New York, New Hampshire and Maine by United States army engineers. In 1822(?) the Northwest Boundary Commission, appointed under the Treaty of Ghent, made a survey of the boundary in the region about the outlet of Lake Superior, and in 1857–61 the United States Commission working under direction of the State Department surveyed the boundary west from longitude 110°. In 1872–75 the United States Boundary Commission under the State Department surveyed the Canadian boundary along the 49th parallel and a narrow strip of contiguous country from Lake of the Woods to the Rocky Mountains, connecting there with the survey from the west. The Louisiana-Texas line survey in 1840 was made jointly by engineers of the United States army and surveyors appointed by Texas. The results are in Senate Ex. Doc. 199, 27th Congress, 2d Session. Considerable boundary surveying has been done by the Coast and Geodetic Survey. The Mexican Boundary Survey was made by Maj. W. H. Emory in 1855–56 and its results were published in two quarto volumes which included geological observations by Parry and Schott. Detailed remapping of this boundary in 1889 was done by a joint International Boundary Commission consisting of three Mexican members, two army engineers and a member of the United States Coast Survey. The result was a folio of maps showing topography and profiles from El Paso to the Pacific. The southern boundary of Kansas was surveyed by Lieut.-Col. J. E. Johnson in 1857 and the Texas boundary in 1858–60 by a commission organized by the Interior Department.

Lake Survey.— A survey of the Great Lakes was made by the War Department (corps of engineers) in 1841 to 1881. Very detailed charts (79) were prepared of the lakes, their shores and of the straits and rivers immediately connected with lake navigation. In 1876–79 this work was extended down the Mississippi River to Memphis.

Hayden Surveys.— The survey under F. V. Hayden began in 1867 for the General Land Office and its work was in Nebraska Territory, but it was not until 1871 that it began much surveying. In 1873 it became the United States Geological and Geographical Survey of the Territories and in the next five years covered 170,000 square miles with topographic and geologic mapping, mostly in Colorado, Wyoming, Idaho and Montana. James T. Gardner was chief geographer and A. D. Wilson and Henry Gannett were in charge of parts of the work. The principal geologists were A. C. Peale, W. H. Holmes, A. R. Marvine, F. H. Endlich and F. V. Hayden. Twelve annual reports and a series of quarto memoirs were published.

Geological and Geographical Survey of Rocky Mountain Region.—These surveys were organized and conducted by Maj. J. W. Powell under the Interior Department. In 1869 Major Powell made his famous boat trip through the Grand Canyon under auspices of Smithsonian Institution. In 1871 continuation of his explanatory work in the West was provided for by the government and from that time to 1878 an area of 67,000 square miles was covered by topographic and geological surveys. A. H. Thompson was chief geographer and G. K. Gilbert, E. E. Howell, Capt. C. E. Dutton and C. A. White were assistant geologists.

Fortieth Parallel Survey.— This survey organized and conducted by Clarence King and under direction of the chief of engineers, United States army, operated from 1867 to 1872. It prepared topographic (contour) maps and geological map of a wide strip of country contiguous to the 40th parallel west of the 105th meridian. The geological work was by Clarence King, S. F. Emmons, Arnold Hague and James D. Hague. John D. Gardner was in charge of topographic work. The results were published in seven quarto volumes and a folio.

Wheeler Survey.— From 1869–79 extensive explorations were made in the West under direction of Capt. G. M. Wheeler of the United States army engineers. The title of the organization was United States Geographical Surveys west of the 100th meridian. Many hachured topographic maps were prepared of parts of Arizona, Utah, New Mexico and Colorado and the geology of various regions was mapped by G. K. Gilbert, A. R. Marvine, E. E. Howell, J. J. Stevenson, I. C. Russell and others. The principal results were published in three quarto volumes issued in 1875, 1881 and 1889.

United States Geological Survey.— In 1876 there were four geological surveys in progress, the Hayden, King, Wheeler and Powell with some duplication of work, a condition which roused so much criticism that Congress referred the consideration of the continuance of the work to the National Academy of Science. That body recommended the substitution of a single organization for the topographic and geologic work, and accordingly in 1879 Congress created the United States Geological Survey (q.v.) as a bureau of the Interior Department. This survey has been continued by annual appropriation (about $1,500,-

000 in 1917). It has made detailed topographic maps of 40 per cent of the area of the United States. Large areas have also been mapped geologically, considerable public land classified in various ways and water resources determined. The maps are on various scales and sold at cost of paper and printing, most of them by the survey. Many of the geological reports are for gratuitous distribution. Two hundred and eleven folios of the Geologic Atlas of the United States have been issued which sell from 25 to 75 cents each.

Reclamation Service.— Many detailed surveys have been made by the Reclamation Service in connection with its various projects, and many suggested ones. Some of the resulting maps have been issued in the various annual reports of the bureau and others are filed.

Isthmian Surveys.— Many surveys have been made by parties sent to the Central America and Panama by the United States government to obtain data for canal routes.

General Land Office.— The General Land Office created in 1812 (see PUBLIC LANDS) and since 1849 a bureau of the Interior Department, has surveyed a large proportion of the public lands in the States west of the Mississippi River, except Texas, and also Ohio, Illinois, Indiana, Florida, Alabama, Wisconsin and Michigan. Many of the State lines were run by the Land Office. In the surveys by this bureau public lands are divided into townships six miles square, comprising 36 sections one mile square, the latter divided into quarter sections of 160 acres and in some cases, minor divisions, a system devised by Lieutenant-Colonel Mansfield in 1803. The enclosing lines are due north and south and east and west and owing to convergence of meridians and varying length of parallels at different latitudes the divisions are only approximate. The townships are numbered east and west from prime meridians, and north and south from standard parallels. The sections, ordinarily a mile square, are numbered thus:

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Thus, for instance, a piece of land is designated NW¼ Sec. 28, T. 19 S., R. 28 W. New Mexico. Farther subdivision is indicated by ¼, ½ sections, and odd areas as lots. The maps are prepared on a scale of two inches to one mile and in most cases the configuration of the land is represented by hachures excepting in later work in a few Indian reservations where contour lines have been used. This mapping covers most of the smooth surfaced or rolling lands but large areas of mountain lands are not yet subdivided. The maps are not issued but held in file in the general land office and local land offices in various public land States. The bureau does, however, issue general maps of the States and of the United States compiled largely from its own surveys.

Coast and Geodetic Survey.— The work of mapping the coast of the United States was initiated by Congress, 10 Feb. 1807, on recommendation of Thomas Jefferson, with an appropriation of $50,000. F. R. Hassler was its first superintendent, beginning work in 1816 and continuing to 29 April 1818 as a bureau of the Treasury Department. The surveys were then continued by the United States army engineers and by officers of the navy until the bureau resumed operations again in 1832 under the Navy Department with Hassler again as superintendent. On reorganization late in 1843 A. D. Bache became superintendent and he continued in charge until his death in 1867. Pierce, Patterson, Hilgard, Thorn, Mendenhall, Duffield, Pritchett, Tittmann and Jones were later superintendents. The geodetic work or determination of the form of the earth was made an additional function of the survey in 1878. The survey has prepared charts of the coasts and exterior waterways of the United States and of parts of its possessions, and mapped more or less of the coast, the District of Columbia and other areas. Many special reports on geodesy, tide tables and scientific researches of the bureau have been issued. The charts which are issued in sheets of various sizes and scales are sold at low rates directly by the bureau and by local agents in seaboard cities.

Mississippi and Missouri River Commissions.— The Engineers corps, War Department has made a detailed survey of the Mississippi River and of its principal tributaries, showing topography of the shore, 1876–84. These surveys were intended primarily for guidance in the many engineering problems connected with improving the waters for navigation, a task on which the government had expended nearly $150,000,000 up to end of June 1916. The War Department has made special surveys for many river and harbor improvement projects.

Hydrographic Office (q.v.).—To this branch of the Navigation Bureau of the Navy Department is entrusted the preparation of many kinds of data relating to navigation. Numerous maps are produced in many cases based on original surveys.

Forest Service.— The Forest Service of the Agricultural Department has made surveys in most of the Forest Reservations in some cases with detailed representation of topography and distribution of various kinds of timber. A series of atlases has been published and many maps are on file in the various offices of the bureau. Some work of this kind was also done by the United States Geological Survey in 1897-1900 and many maps were published in annual reports and professional papers. Since 1897 this survey obtains data as to forested areas in all districts mapped topographically.

Soil Surveys.— The Agricultural Department has made surveys of soils in many parts of the United States, publishing the results on the detailed topographic maps by the United States Geological Survey. These soil maps are issued for gratuitous distribution.

Biological Survey.— The Agricultural Department is also conducting a survey to ascertain the geographic distribution of animals and plants.

Bibliography.— 'United States Geological and Geographic Surveys,' G. M. Wheeler, Vol. I, pp. 519–745; 'Report of Third International Geographic Congress' (Venice, Italy, by G. M. Wheeler, 48th Congress, Second Session. H. of R. Ex. Doc. 270, 1885); Emmons, S. F., 'The Geology of Government Explorations' (Geological Society of Washington, 1896); Merrill, G. P., 'Contributions to the History of American Geology' (Report of United States National Museum, 1904, pp. 189–734).

N. H. DARTON,
United States Geological Survey.

SUSA, soo'sä, Persia, capital of the province of Susiana or Elam, on the Choaspes River, 50 miles west of Shuster, was one of the celebrated cities of the Old World, renowned in Biblical history. Shushan, meaning lilies, is alluded to in the Old Testament and on the cuneiform tablets of Assyria. It has a rectangular form without walls, but possessed a strongly fortified citadel, which enclosed the stately palace and one of the most important treasuries of the Persian kingdom. Numerous rivers water the plain in which it stands, some of which partly surrounded the ancient city. All the Persian kings, beginning with Darius I, erected beautiful palaces, the remains of which belong to the most magnificent ruins of Asia. It was here that Esther's intrigue was developed; Daniel saw the vision at Shushan, and here he was buried. Consult Billerbeck, 'Susa' (Leipzig 1893); Dieulafoy, 'L'Acropole de Suse' (Paris 1888–92); de Morgan, J., 'Fouilles à Suse' (Paris 1900).

SUSAN NIPPER, a character in 'Dombey and Son' by Charles Dickens. She is an attendant upon Florence Dombey and is noted for her sharp tongue.

SUSANNA, soo-zăn'a, the Jewish woman who figures in the book of Susanna, as the intended victim of two elders who obtained her condemnation to death on a false charge. The prophet Daniel proved her to be innocent, and obtained a reversal of the sentence. The date of about 600 B.C., is ascribed to the event. See SUSANNA, BOOK OF; BIBLE.

SUSANNA, Book of, the 13th chapter of Daniel in the Septuagint version of the Old Testament. It is accepted as canonical by Roman Catholics, but rejected by Protestants. (See BIBLE). Consult Kay, D. M., in Charles, 'The Apocrypha and Pseudepigrapha of the Old Testament' (Oxford 1913).

SUSPENSION, *in canon law,* a censure of which a clergyman is forbidden to exercise his order or to enjoy the fruits of his benefice. Partial suspension inhibits a cleric from the exercise of his spiritual functions, or from the administration of his benefice, or only from a part of his sacred functions: for example, a bishop may be suspended from ordaining, and yet be perfectly free to govern his diocese. Entire suspension prohibits all use of order, jurisdiction or benefice. In the English canon law, as in that of the Roman Catholic Church, a suspension is removed by absolution, by revocation of the censure by the person inflicting it or by dispensation.

SUSPENSION BRIDGE. See BRIDGE.

SUSPENSION RAILWAY, a railway in which the carriage is suspended from an elevated cable or track. See MONORAIL.

SUSQUEHANNA, Pa., borough of Susquehanna, on the Susquehanna River and on the Erie Railroad. It is 38 miles north of Carbondale and 23 miles southeast of Binghamton, N. Y. It has machine shops, chemical works and manufactures of washing machines and metal ware. Pop. 3,478.

SUSQUEHANNA, sŭs-kwē-hăn'a, a river formed by two branches, an eastern or northern and a western, which unite at Northumberland in Pennsylvania. The eastern branch, which is considered the main stream, issues from Lake Otsego in New York, and has a length of about 250 miles. The western branch rises in the western slope of the Alleghenies, and flows very circuitously east-southeast for about 200 miles. The united stream flows south and southeast, passing Harrisburg, Wilkesbarre and Binghamton, N. Y., enters Maryland, and after a course of about 150 miles flows into the northern extremity of Chesapeake Bay at Port Deposit. The navigation was much obstructed by rapids, but by constructing canals the river has been made navigable for a considerable distance from the Chesapeake.

SUSQUEHANNA COMPANY, The, in American history a land company formed in 1754, chiefly by Connecticut farmers, for the colonization of the Wyoming country. By a treaty with the Five Nations, 11 July 1754, an enormous tract of country was purchased for $10,000. It began at the southern boundary of Connecticut and followed in a northerly direction the course of the Susquehanna to northern Pennsylvania. In 1785–86 many disputes arose between the Susquehanna Company and the Pennsylvania claimants of the territory. This was called the «Pennamite War.»

SUSQUEHANNA UNIVERSITY, a Lutheran institution of higher education at Selingsgrove, Pa., founded in 1858. The faculty numbers 22; the average annual attendance of students is 325; tuition fees are $75 to $90; living expenses, board, etc., $175 to $225; the productive funds amount to $72,000; the total income, including tuition and incidental charges, amounts to $42,000. The college colors are orange-maroon. The library contains over 16,000 volumes. The number of graduates since organization number over 1,000.

SUSSISTINNAKO, the Spider, was according to the Sia Indians of New Mexico, the first of all beings in the lower world. He lay out the directions by drawing one line of meal from east to west and another from north to south. Within the magic confines thus laid out he sang his magic songs and rattled his magic rattle, and as he sang and rattled people, animals, birds and insects appeared at his call. He created two mothers who were the mothers of all; then he divided the people into clans, after he had created the earth for them, and he made the Cloud People, the Lightning People, the Thunder People and the Rainbow People, and he commanded them to work for the people of Haarts (the earth). He divided the world into three parts: Haarts (the earth); Tinia (the mid-plain); and Huwaka (the upper plain); and to the Clouds and the Rainbow he gave the Middle Plain. When all this had been done he had the two original mothers create the sun, the moon and the stars.

SUSTENTATION FUND, the name specifically applied in the Presbyterian denomination to a fund for the support of poorer churches. All important religious bodies have funds of this character. The object is to enable communities unable from their own means to support properly a pastor or minister, to have the benefit of religious services.

SUTHERLAND, Alexander, Canadian Methodist clergyman: b. Guelph, Ontario, 17 Sept. 1833; d. 1910. He learned the printer's trade, but studied for the ministry and in 1859 was licensed as a preacher and stationed at Niagara. He removed to Therold in 1861 and afterward preached at Drummondville, Hamilton, Yorkville, Toronto and Montreal. He was secretary of the Conference in 1870–71, and after the union of the Methodist churches in Canada he was secretary and treasurer of the missions of the Church. In this capacity he made extended tours of Canada; and in 1879 he inaugurated a campaign to raise $75,000 for the purpose of clearing the missions department of debt and succeeded in raising $116,000. Author of 'A Summer in Prairie Land' (1882).

SUTHERLAND, George, United States senator: b. Buckinghamshire, England, 25 March 1862. He came to the United States with his parents in 1864, received his academical education in Utah and studied at the University of Michigan in 1882–83. He was admitted to the bar in 1883 and engaged in practice at Salt Lake City. He was elected to the first Utah senate by the Republican party in 1896; served in Congress in 1901–03 and in the United States Senate in 1905–17.

SUTHERLAND, Howard, United States senator: b. near Kirkwood, Mo., 8 Sept. 1865. In 1889 he was graduated at Westminster College, Fulton, Mo., studied law at Columbian (now George Washington) University, but did not complete course. In 1889–90 Mr. Sutherland was editor of the *Republican* of Fulton, Mo., and from 1890 to 1893 served from clerk to chief of population division of the 11th census. In 1893 he removed to Elkins, W. Va., where for 10 years he was connected with the Davis-Elkins coal and railway interests, becoming their general land agent. For some years he has engaged in coal and timber land operations on his own account and is president of the Greenbrier Land Company of Valley County. In 1908–12 he was member of the West Virginia State senate and from 1913 to 1917 was a member of the 63d and 64th Congresses, serving as member-at-large from West Virginia. In 1916 he was elected to the United States Senate for the term 1917–23. Senator Sutherland is a member of the American Academy of Political and Social Science.

SUTLEJ, sŭt'lĕj, India, a river forming the eastern boundary of the Punjab. It rises in Tibet, in the sacred lakes of Manasarowar and Rakas-Tal, flows through the latter lake at an elevation of 15,000 feet, follows a circuitous course through the Himalayas, finally joining the Indus at Mithankot. Its principal tributaries are the Li, Beas and Chenab; it passes in its upper course through scenery of a wild and savage grandeur. Its entire length is 900 miles; a swift current marks its upper course, often forming deep cascades and waterfalls; it is navigable only in its lower course. The river is spanned by splendid bridges, that of the Indus Valley Railway connecting the shores near Bhawalpur, and another iron bridge of the Sind, Punjab and Delhi Railway, near Jullunder.

SUTPHEN, William Gilbert Van Tassel, American author: b. Philadelphia, 11 May 1861. He was graduated at Princeton in 1882; since engaged in editorial work. He has written 'The Golficide' (1898); 'The Cardinal's Rose' (1900); 'The Golfer's Alphabet' (1899); 'The Nineteenth Hole' (1901); 'The Doomsman' (1903); 'The Gates of Chance' (1904), etc.

SUTRA, soo'tră, in Sanskrit literature, the technical name of aphoristic rules and of works consisting of such rules. There is a bibliography of sutra texts in Macdonell's 'History of Sanskrit Literature' (London 1913). See SANSKRIT LITERATURE.

SUTRO, soo'trō, **Adolph Heinrich Joseph,** American engineer and philanthropist: b. Aix-la-Chapelle, Rhenish Prussia, 29 April 1830; d. San Francisco, 8 July 1898. Coming to the United States in 1850 he went to California where he engaged in business for 10 years. In 1860 he visited Nevada and planned the Sutro tunnel, a charter being secured on 4 Feb. 1865. It was begun on 19 Oct. 1869 and cost nearly $4,000,000. The main tunnel is 20,000 feet long, 1,650 feet below the surface, 12 feet wide and 10 high. On the discovery of gold, years before, he had invested heavily in San Francisco real estate and became very rich. In 1894 he was elected mayor of that city, to which he gave a park and other gifts. His library of 250,000 volumes was peculiarly rich in works on the history of the Pacific settlement. The library was almost totally destroyed in the fire following the earthquake of April 1906. The 100,000 volumes saved were, after continued litigation, turned over to the State Library in 1913.

SUTRO TUNNEL. See TUNNELS AND TUNNELING.

SUTTAS, Buddhist, a collection of the most important religious, moral and philosophical discourses taken from the sacred canon of the Buddhists. It gives the most essential, most original and most attractive part of the teaching of Buddha, the Sutta of the Foundation of the Kingdom of Righteousness and six others of no less historical value, treating of other sides of the Buddhist story and system. The translator, T. W. Rhys Davis, gives as the dates of Buddha's life of 80 years about 500–420 B.C.

SUTTEE, sŭ-tē', in India, a term applied to the self-immolation of Indian widows on the funeral pile of their deceased husbands. The origin of this practice is of considerable antiquity, but it is not enjoined by the laws of the great legislator, Manu, nor is it based on the Vedas. This practice was abolished by Lord

Bentinck, governor-general of India, in December 1829, and may now be said to be extinct, though perhaps rare cases still occur. Until then the British government had permitted it, provided the act was perfectly voluntary (which the religion of Brahma also prescribes), and if notice of such resolution had been previously given to a magistrate, who was required to see that the suttee was public and that all the requisitions of the law were fulfilled. The ceremonies of a suttee were various and lasted from a quarter of an hour to two hours. Sometimes the widow was placed in a cavity prepared under the corpse of the husband; sometimes she was laid by the body, embracing it. If the husband died at a distance from home, anything which belonged to the deceased — his garments, slippers, walking-staff — might be substituted for the corpse. Consult Bose, J. C., 'The Hindus as they Are' (2d ed., London 1884), and Tylor, E. B., 'Primitive Culture' (4th ed., 2 vols., New York 1903).

SUTTER, John Augustus, American pioneer: b. Kandern, Germany, 15 Feb. 1803; d. Washington, D. C., 17 June 1880. He was graduated at the Bern Military Academy in 1823 and came to America in 1834, locating at Saint Louis. Receiving favorable accounts of California he crossed the Rocky Mountains in 1838; sailed down the Columbia River and thence to Hawaii. After going to Sitka, Alaska, he cruised along the Pacific Coast and was stranded at the site of San Francisco in July 1839. During that year he established the first white settlement on the site of Sacramento. In 1841, after receiving a large tract of land from Mexico, he built a fort which he named New Helvetia on the site of the present Sacramento, Cal.; was made governor of the frontier country by Mexico, but was held in suspicion by the Mexicans owing to his friendly feelings toward the United States. In 1848, when California was ceded to the United States, he owned many thousand head of cattle, much land and other property, but owing to the discovery of gold his estates were overrun by miners, and his workmen left him, and not being able to secure others he was financially ruined. He appealed to the Supreme Court, but was not sustained. Later the legislature of California granted him a pension of $250 a month. He moved to Littz, Pa., in 1873. (See SACRAMENTO, CAL.). Consult Dellenbaugh, F. S., 'Frémont and '49' (2d ed., New York 1914).

SUTTNER, Bertha, BARONESS VON, Austrian author and worker for universal peace: b. Prague, 9 July 1843; d. Vienna, 21 June 1914. She was the daughter of Count Franz Kinsky, an Austrian field-marshal, who died in her infancy. She was excellently educated, traveled extensively, and in 1876 she was married to Freiherr Arthur Gundaccar von Suttner, the novelist, who died in 1902. She was for a time secretary to Alfred Nobel, and for the greater share of her life was an indefatigable worker for world peace. She was widely known as a writer of fiction, on social science and on a world union to ensure peace. She was awarded the Nobel Peace Prize in 1905. Author of 'Inventarium Einer Seele' (1882); 'Die Waffen Nieder' (1889); 'Hanna' (1894); 'Krieg und Frieden' (1896); 'Schack der Qual' (1898); 'Die haager Friedenskonferenz' (1900); 'When Thoughts Will Soar' (1914); 'Der Kampf um die Vermeidung des Weltkriegs' (2 vols., 1917), etc. Consult her 'Memoirs' (Stuttgart 1908; Eng. trans., Boston 1910).

SUTTON, Mass., village and township in Worcester County, eight miles southeast of Worcester, on the New York, New Haven and Hartford Railroad. There are manufactures of cotton goods. Pop. town, 2,829.

SU TUNG P'O, or SOO TUNG P'O, also known as **SU SHIH,** Chinese poet, essayist and statesman: b. 1031–36; d. 1101. He was educated under the care of his mother and passed first on the list when he was examined for his degree. He was at various times the holder of high offices at court, but was several times banished through the jealousy of enemies. He was a brilliant writer of verse and essays, and holds a high place in Chinese literature. Consult Giles, H. A., 'Gems of Chinese Literature' (1884); 'A History of Chinese Literature' (1901).

SUTURE, a line along which two things are joined, as by sewing, etc., so as to form a seam or something resembling a seam. In anatomy a suture is the immovable junction of two parts by their margins. The sutures of the skull are the lines of junction of the bones of which the skull is composed. Various types of suture exist, as the serrated or dentated suture, the squamous or scaly suture and the harmonic suture or harmonia. Arranged according to their situation, there are coronal, frontal, fronto-parietal, occipito-parietal and many other sutures. In surgery a suture is the uniting of the lips or edges of a wound by stitching. In zoology sutures are the outlines of the septa in the *Tetrabranchiata,* so named from their resemblance to the sutures of the skull. When these outlines are folded the elevations are called saddles and the intervening depressions lobes. In botany a suture is the line formed by the cohesion of two parts. If the suture formed by the carpellary leaves in a pistil face the centre of a flower it is called the ventral suture; if it face the perianth, the dorsal suture. The former corresponds to the margin and the latter to the midrib of the carpellary leaf. Consult Da Costa, J. C., 'Modern Surgery' (7th ed., Philadelphia 1914).

SUVA, soo'vä, the capital of the British colony of the Fiji Islands (q.v.). It is about 1,100 miles distant from Auckland, New Zealand. It has a population of over 1,300 Europeans.

SUVALKI, soo-väl'kē, Poland, (1) capital of the province of the same name, on the Czarna-Hancza, near the Prussian frontier, 152 miles northeast of Warsaw. It contains two churches, municipal buildings and a large market-place, various schools of primary and grammar grades, two breweries, etc. Pop. about 33,000. The town was taken by the German forces in 1915. (See WAR, EUROPEAN). (2) The province of Suvalki lies in the extreme northeastern part of Poland. In the north is covered by thickly-wooded plains and on the Prussian frontier by forests, swamps and lakes. The fertile region is at the south. The chief streams are the Niemen, Bohr, Scheschupe and Pissia. Agriculture is the principal occupation.

There are numerous factories, including tanneries, distilleries and mills. There are some schools. Area, 4,763 square miles. The population is about 700,000, of whom 50 per cent are Lithuanians.

SUVOROFF-RIMNIKSKI, soo-vō'rŏf rim-nyĭk'skĭ, **Alexander Vasoilievitch** (Prince Italieski), a celebrated Russian general: b. in Moscow according to one account, in Finland according to another, 24 Nov. 1729; d. Saint Petersburg, 18 May 1800. He entered the army as a private, fought bravely in the war against Sweden and by his distinguished conduct during the Seven Years' War gained the rank of colonel (1762). He participated in the suppression of the Polish uprising of 1768–72, capturing Cracow in the first year of the conflict and attaining the rank of major-general. When war with Turkey broke out in 1773, Suvoroff as general of division achieved notable victories at Turtukai and Hirsuva, and in conjunction with a force under Kainenskvi completed the overthrow of the Turkish armies at Kosludji beyond the Danube. Subsequently he fought against the pretender Pugatcheff, whose overthrow was largely due to his exertions, and made successful campaigns in Crimea, against the Kuban Tatars and against the mountain tribes of the Caucasus. Upon the renewal of war with Turkey in 1787 he was entrusted with the chief command, and after inflicting decisive defeats upon the enemy at Kinburn, Otchakov and Tokshani, performed the most splendid feat of arms of the entire war by effecting the rescue of the Austrian army under the Prince of Saxe-Coburg, which was surrounded on the banks of the Rymnik by a vastly superior Turkish force, which Suvoroff utterly overthrew, gaining thereby the title of Rimnikski and the rank of count. In 1790 he stormed Ismail, where his troops were guilty of the most bloody excesses. Sent in 1794 against the Polish insurgents he gained the title of field-marshal by his storming of the Praga, suburb of Warsaw, and the occupation of the Polish capital. After five years of retirement, he was summoned to take command of the Russian forces which were to co-operate with the Austrians against the revolutionary armies of France in Italy. At 70 Suvoroff was to achieve the most notable triumphs of his career. Arriving in Italy in April 1799 he succeeded within four months in driving the French from the northern part of the country, after he had defeated their armies at Cassano, 27 April, on the Trebbia, 17–19 June and at Novi, 15 August. Thereupon he crossed into Switzerland to effect a junction with a second Russian army under Korsakoff. The crossing of the Saint Gotthard pass was accomplished only after fearful hardships, with the loss of one-third of his army and all his guns. In Switzerland he found that Korsakoff had been defeated by Masséna and that the French were masters of the country. He thereupon began a retreat through the Grisons and Vorarlberg, in which he displayed some of the highest qualities of his generalship. Setting out on the way to Russia, after he had been named commander-in-chief of all the Russian forces with the title of Prince Italieski, he lost the favor of the Emperor Paul before his arrival in Saint Petersburg, where after a short ailment he died. Consult Smith, F., 'Suworow's Leben und Heerzüge' (Vilna 1833–34); also his 'Autobiography,' edited by Glinka (1819); and biographies by Polevoi (1853); Spalding (1890). Consult also Macready, E. N., 'A Sketch of Suwarrow and his Last Campaign' (London 1851), and Reding-Biberegg, 'Der Zug Suworows durch die Schweiz' (Zürich 1869).

SUWANNEE, sū-wā'nē, a river in southern Georgia, in the Okefinokee Swamp, which flows in a winding, generally south-southwest course through Florida into the Gulf of Mexico, about 10 miles north of Cedar Keys. It is the subject of the popular ballad, 'Old Folks at Home,' beginning «Way Down on the Suwannee River.» Its total length is about 240 miles.

SUWARROW, soo-vä'rŏv, or **SUVAROF**, a group of islands in the Pacific Ocean, between Samoa and the Manihiki Islands, is generally included in the Tokelan Islands. It has important pearl fisheries. Great Britain annexed the islands in 1889.

SUYEMATSU, Kencho, Viscount, Japanese statesman, son-in-law of Marquis Hirobumi Ito (q.v.): b. Bunzen, Kiusiu, August 1855. He served in the Satsuma Rebellion as civilian staff officer to the commander-in-chief of the army, and later engaged in journalism on the staff of *Nichi Nichi*. In 1890–95 he was a member of the Japanese House of Commons, and after he was created baron in 1895 he served in the House of Peers. He was director of the Legislative Bureau in 1892–1905; Minister of Communications in the Ito Cabinet in 1898; and held the portfolio of the Interior in the Seiyukai Cabinet in 1900–01. He served as a non-official agent for Japan in London during the Russo-Japanese War in 1904–05. He was made a viscount in 1907. He translated into English 'Genji Monogatari'; and is author of 'The Risen Sun: A Fantasy of Far Japan' (1915).

SUZZALLO, Henry, American university president: b. San José, Cal., 22 Aug. 1875. He was graduated at the California State Normal School in 1895, at Leland Stanford Junior University in 1899 and took his Ph.D. at Columbia University in 1905. He was connected with the faculty at Leland Stanford Junior University in 1902–07; was professor of the philosophy of education at Teachers' College, Columbia, in 1909–15; and since 1915 has been president of Washington University, Seattle. He has edited the *Riverside Educational Monographs* since 1909, has lectured extensively and is a contributor to educational magazines. He was appointed chairman of the Washington State Council of Defense in 1917.

SVERDRUP, svĕr'drŭp, **Otto**, Norwegian Arctic explorer: b. Harstad Farm, Helgeland, 1855. He went to sea at 17, went with Nansen to Greenland in 1888, and again in 1893, as commander of the *Fram*, which he brought back to Norway in 1896. He led an expedition to the northern regions in 1898, with the intention of exploring the north of Greenland. The expedition received its financial support mostly from two brothers of the name of Ringnes, and the Norwegian government renovated and equipped the *Fram* for his use. On reaching Smith Sound, between Ellesmere Land and Greenland, he found it impossible to force his vessel further north through the ice, and sent two expeditions to the southwest across Ellesmere Land, which penetrated a region never before explored, and found in the southern part of Ellesmere Land a large glacier district. Later in 1899 he brought the *Fram* down to Jones Sound, to the south of Ellesmere Land, and from there conducted a number of sledging expeditions, exploring the southern and western portions of Ellesmere Land. On the southeast coast of Ellesmere Land, north of Jones Sound, a large bay was discovered about 100 miles in breadth and penetrating into Ellesmere. On the northern side of this bay large and complicated fiords are situated. On the west coast of Ellesmere Land, in about 89° W., a large system of fiords was discovered. To the west of Ellesmere Land, about 130 miles north of the Parry Islands, Sverdrup discovered two islands, to the north and west of which nothing was visible but rough polar ice. He returned to Norway in 1902. The discovery of the islands and the mapping of the western and southwestern coasts of Ellesmere Land are the most important results of Sverdrup's expedition. He brought back also a valuable series of meteorological reports, and a representative natural history collection. In 1914–15 he led a relief expedition to the Arctic and wintered on the shores of Kara Sea. He published 'New Land: Four Years in the Arctic Regions' (1904).

SVETLA, Karolina, Bohemian novelist: b. Prague, Austria, 24 Feb. 1830. She gained the attention of the literary critics by her first novel 'A Double Awakening,' published in 1858. She has attained high rank in Bohemian literature, many of her novels being translated into French, German, Polish and Russian. Among them are 'Láska k básnikovi' (1860); 'Vesnicky roman' (1869); 'Kriz a potoka' (1871); 'The Atheist' (1873).

SWABIA, swā'bĭ-a̦, or **SUABIA** (German, SCHWABEN), capital Augsburg, now part of the republic of Württemberg, formerly a duchy in the southwestern part of Germany, occupying the area now covered by Baden, Württemberg and a part of Bavaria. It extended from the Rhine on the west to the Lech on the east, and from Switzerland northward to the Rhine Palatinate. It is a mountainous country, and probably the most picturesque portion of Germany. The region was known in ancient times as Allemannia, and received its present name from the Suevi, who entered it in the 5th century and amalgamated with the Allemanni. In the 10th century Swabia was raised into a duchy which continued in the house of Hohenstaufen until 1268, when it was resolved into a number of lesser principalities among whom there was continual feud. In 1488 these little states formed the famous "Swabian League" for the purpose of securing internal peace and giving mutual aid to each other. In 1512 the emperor, Maximilian I, made Swabia one of the 10 circles into which Germany was divided, and enlarged its territory. This division continued until 1806, when the modern kingdom of Württemberg was founded. (See BADEN; WÜRTTEMBERG). At present the name of Swabia is retained by one of the southwestern provinces of Bavaria. Consult Stalin, B. F., 'Geschichte-Württemberg' (Gotha 1882–87); Schneider, Eugene, 'Württembergische Geschichte' (Stuttgart 1896). See WAR, EUROPEAN.

SWAGE (swāj) **BLOCK,** a heavy iron block or anvil provided with notches and perforations, used by blacksmiths in shaping metal. The swage block is so arranged that it may be readily clamped in any desired position and may as readily be released whenever it is necessary to adjust the anvil to a different position. The block has trunnions or journals which engage open bearings formed on the top of the standards of the frame. The standards are connected with each other at their lower ends by bolts. Midway of their height they are connected by a clamping device which consists of a rod revolubly secured to one standard and threaded into a nut in the other standard. By operating a crank on this rod the upper ends of the standards may be drawn together to bind against the ends of the swage block and hold it from turning. Inwardly-directed flanges are formed on the standards just below the trunnion bearings, and these on being drawn inward form firm supports for the swage block when in horizontal position. The recesses lying between these flanges receive and securely hold the swage block when turned to vertical position. When the swage block is held at other angles the flanges sink into grooves formed in the ends of the block around the journals. The usual variety of notches, recesses, perforations, etc., are provided for assisting in upsetting bolts, shaping horseshoes and forming all other devices which a blacksmith may be called upon to make. The construction of this swage block is the extreme of simplicity.

SWAIN, swān, **George Fillmore,** American civil engineer: b. San Francisco, Cal., 2 March 1857. He was graduated at the Massachusetts Institute of Technology in 1877 and then studied in Berlin, Germany. In 1887 he accepted the chair of civil engineering at the Massachusetts Institute of Technology, where he remained until 1909. He also served as consulting engineer of the Massachusetts Railroad Commission and was member of the Boston Transit Commission and its chairman in 1913. In 1909 he was made professor of civil engineering at the Harvard Graduate School of Applied Science. He is the author of 'Notes on Hydraulics' (1885); 'Notes on Theory of Structures' (1893); 'Report on the Water Power of the Atlantic Watershed' (in Vol. XVII of the 'Tenth United States Census') and 'Conservation of Water by Storage' (1915).

SWAIN, Joseph, American college president: b. Pendleton, Ind., 16 June 1857. He was graduated at the Indiana University in 1883, was assistant professor of mathematics in 1883–86 and full professor, 1886–91. He was called to the chair of mathematics in the Leland Stanford Junior University in 1891, which he held till 1893, and was president of Indiana University, 1893–1902. Since the last-named date he has been president of Swarthmore College. He is the author of numerous scientific papers. In 1913–14 he was president of the National Education Association.

SWALLOW HOLES. See SINK HOLES.

SWALLOW-TAILED BUTTERFLIES, butterflies of the family *Papilionidæ*, typical species of which have the hinder wings extended into prolongations called «tails.» See BUTTERFLY.

SWALLOWS, a family (*Hirundinidæ*) of passerine birds which are the counterpart in this order of the swifts (q.v.). This family is distinguished by the small, flat, triangular bill which has its sides gradually compressed toward the tip and the deeply cleft mouth, the margins of which bear very small bristles or none; the nostrils rounded at the base of the bill, either exposed or covered by a scale. The wings are long, while the tail is forked in nearly all species and the outer feathers may be prolonged. The feet, although small and weak, are totally unlike those of the swifts, the hind toe being never versatile, the number of phalanges not different from that of ordinary birds and the squamation normal; sometimes the tarsi and toes are feathered. In striking contrast to the somber-hued swifts, many of the swallows are adorned with rich iridescent colors and sometimes the sexes differ. Anatomically the swallows are truly passerine, but the fissirostral bill and mouth, together with their peculiar adaptations to life awing, makes them one of the most clearly circumscribed and natural families of that order. Owing to the many interesting modifications of the type the genera are numerous and many of them restricted in distribution; but the more generalized genera, like the typical *Hirundo*, are, like the family, cosmopolitan. About 100 species have been described. Belonging to the North American fauna are 10 species representing no less than seven genera, most of which are peculiarly American. The barn-swallow (*Hirundo* or *Chelidon erythrogaster*) is abundant throughout North America and is easily distinguished by the elongated outer tail-feathers, the lustrous steel-blue color of the upper parts and the ruddy breasts. (See BARN-SWALLOW.) The cliff or eaves swallow is colored much like the barn-swallow, but the tail is shorter and only slightly forked; it makes retort-shaped nests outside of barns, etc., under the eaves, as it formerly did on the faces of cliffs.

One of the swallows which retains its original habits is the beautiful white-bellied or tree-swallow (*Tachycineta bicolor*). It is of a fine lustrous green above, pure white below, with a tail only slightly more forked than in the last. The tree swallow is abundant in most parts of temperate North America, but especially so coastwise where great numbers nest in holes of trees from New Jersey northward. It is one of the first swallows to move northward in the spring and is frequently forced to retreat before a belated snowstorm or cold snap, being, therefore, one of the species to which the common saying, «one swallow does not make a summer,» is especially applicable. In the West a related species, the violet-green swallow (*T. thalassina*), is found. Another conservative member of the family is the bank-swallow, which is found in Europe as well as in America. Closely resembling it is the rough-wing.

Biggest, handsomest, jolliest, most domestic of American swallows and ever ready to defend his home is the purple martin (*Progne subis*), a familiar species throughout temperate North America, distinguished as a genus (*Progne*) by the strong bill with curved edges, by the moderately-sized forked tail, and by the strong and large feet. The sexes are quite dissimilar, the male being entirely blue black, the female and young, dull sooty gray on the breast. Except in the wilds where it continues to nest in hollow trees, it takes up its abode among the habitations of men. A common practice is to hang up gourds, properly hollowed, for its convenience in nest-building; and in the more settled parts considerable expense is sometimes incurred in preparing for it a suitable residence. The eggs are four to six in number and white. In the country it renders essential services by attacking and driving away crows, hawks, eagles and other large birds. Its note is loud and musical. The regularity with which this species arrives from the South is noteworthy. The western variety is distinct and another species enters Florida.

Of exotic species of swallows the *Hirundo rustica* takes the place in Europe of our barn-swallow. On account of its frequent use of disused chimneys for nesting places this species shares with the swifts the name of chimney swallow. The migration of these birds has always attracted attention from the well-known and unvarying character of their movements. They fly southward at the end of October or sometimes sooner, to winter in Africa, some finding their way to India. The majority arrive in Great Britain in April, some stragglers later and a few coming before the great body of birds. They generally return to the nests they have constructed the previous year. The house martin (*Chelidon urbica*) with the tarsi and toes feathered is of small size. It is of smaller size than the common swallows, and builds its nest under the eaves of houses, in the corners of windows, etc., the nest being a hemispherical structure of clay, with a round opening for entrance. A related species is the fairy martin (*C. ariel*), found in South Australia, where it arrives in August, leaving again in September or October. The nest, built in some tree, under eaves or in rocks, is formed of mud, and is of flask-like shape. Each nest appears to be built by a number of these swallows. The wire-tailed swallow (*C. filifera*) of Abyssinia is so named from the presence of the two elongated tail-feathers, which, being unprovided with a web, consist of the shafts of the feathers alone, and appear as long filaments. The genus *Atticora* includes the white-breasted swallow of South America (*Atticora cyanoleuca*), which makes its nest in the deserted burrows of animals. A number of other South American swallows have similar habits, occupying the nests or holes of various birds and mammals.

Consult Sharpe and Wyatt, 'Monograph of the Hirundinidæ' (London 1885–94), with bibliography and numerous colored plates; Forbush, 'Useful Birds and their Protection' (Boston 1913); Wilson, 'American Ornithology' (Philadelphia 1828); and recent works on field ornithology.

SWAMMERDAM, swăm'mĕr-dăm, **Jan**, Dutch naturalist: b. Amsterdam, 12 Feb. 1637; d. there, 15 Feb. 1680. He was educated for the ministry but turned his studies to the profession of medicine. He was devoted especially to the study of insects; and his 'General History of Insects' and other works laid the foundations of the modern science of entomology. These works include 'Tractatus de Respiratione usuque Pulmonum' (1667; Allgemeene verhandeling van bloedeloose dierjes' (1669); 'Biblia Naturæ, sive Historia Insectorum in certas classes Redacta' (1737–38).

SWAMP. See Bog.

SWAMP ANGEL, in the American Civil War the popular name of an 8-inch Parrott gun, so called by the Federal soldiers. It was mounted on a battery constructed on piles driven into the swamp near Charleston, S. C., and was used in the siege of that city. It burst 22 Aug. 1863, and was sent with a lot of old metal to Trenton, N. J. The gun was rescued from its impending fate and set on a granite base on the corner of Perry and Clinton streets in the city of Trenton.

SWAMP DEER, or BARASINGHA, an East Indian deer (*Cervus duvaucelli*), about four feet in height, rich light yellow in color, found in large herds in moist situations. The antlers are large, with a long beam which branches into an anterior continuation of the main portion, and a smaller posterior tine which is bifurcated.

SWAMP GRASS. See Grasses in the United States.

SWAMP HICKORY. See Hickory.

SWAMP LAND GRANTS. The need of reclaiming the swamp and overflowed lands within the territory of the United States was brought to the attention of Congress in the early part of the 19th century. It was not, however, until the Act of 2 March 1849 that Congress made provision for the reclamation of such lands. This Act applied exclusively to the State of Louisiana, and provided that in order to aid the State in constructing the necessary levees and drains to reclaim the swamp and overflowed lands therein the whole of such lands that may be found unfit for cultivation were granted to the State with the proviso that the proceeds of the sales of all such land shall be applied exclusively as far as necessary to the construction of levees and drains for their reclamation.

This was followed by the Act of 28 Sept. 1850 which provided for a similar grant to the State of Arkansas. This act contained a section which extended its benefits to each of the other States of the Union in which such swamp and overflowed lands may be situated.

By the Act of 12 March 1860 the provisions of the Swamp Acts were extended to the States of Minnesota and Oregon which had been admitted to the Union since the passage of the Act of 1850. The reasons assigned for these grants were the worthless character of the lands in their present condition, the unhealthful effects of these lands and the enhancement in value of the adjoining government property.

At the time of this legislation it was estimated that the area of lands involved would be about 5,000,000 acres. However, up to 30 June 1918 there had been conveyed to the several States under these grants 64,258,731.04 acres. In addition there have been granted to the States 744,385.23 acres as indemnity for lands which had been disposed of to settlers prior to the time when the several grants became effective and also a cash indemnity in lieu of lands which would otherwise have been granted, amounting to $2,095,466.70. Comparatively small additional claims are coming in under these grants.

In spite of these liberal grants of land and money the States have not drained the great body of land actually granted and in many cases the proceeds from the sales of the lands have been used for other purposes. The same reasons for reclaiming these lands which formed the original basis for these grants, therefore, still exist and the United States government has in recent years spent considerable sums to aid in the development of plans for the reclamation of small bodies of these swamp lands. There has also been a widespread sentiment that something definite should be done to make these lands available for agricultural purposes as the area of actual swamp land in the United States is estimated at from 75,000,000 to 80,000,000 acres.

Morris Bien.

SWAMP LOCUST. See Locust.

SWAMP RABBIT, or WATER HARE. See Hares.

SWAMP SASSAFRAS. See Magnolia.

SWAMPSCOTT, swŏmp'skŏt, Mass., town in Essex County, on Massachusetts Bay, and on the Boston and Maine Railroad, about 12 miles northeast of Boston and two miles northeast of Lynn. The town contains the villages of Beach Bluff, Mountain Park, Phillips Beach and Swampscott. It is a favorite watering place, and has an excellent beach and good accommodations for transient guests. There are several churches, a town high school, district schools, a public library and several private schools. Most of the inhabitants are employed in Lynn. Pop. 7,345.

SWAN, James, American soldier and author: b. Fifeshire, Scotland, 1754; d. Paris, 18 March 1831. He came to Massachusetts at an early age, became an artillery captain, a member of the legislature in 1778, and was subsequently adjutant-general of the State. He went to Paris in 1787 where he wrote 'Causes qui sont opposées au Progies du Commerce entre la France et les Etats-Unis de l'Amérique' (1790). He returned to America in 1795 only to go back to France in 1798. In 1815 he was arrested and imprisoned for 15 years at the suit of a German with whom he had had business relations. Among other books of his are 'On the Fisheries' (1784); 'Fisheries of Massachusetts' (1786).

SWAN, John Macallan, English sculptor: b. Old Brentford, 1847; d. 1910. He studied at the Worcester School of Art and the Lambeth Art School and under Gérôme and Frémiet in Paris. In 1885 he received honorable mention at the Salon, and in 1889 received the silver medal at the Paris International Exhibition. He received the first and second gold medals at Munich and the first class gold medal for painting and the first class gold medal for sculpture at Paris, 1900. Most of his sculptures are studies of animals and in representing the cat tribe he is particularly successful in giving vivacity and vitality to the rapid furtive advance of the leopard or tiger. His principal works are 'Leopard Running'; 'The Prodigal Son'; 'Lioness defending her Cubs'; 'Polar Bears Swimming'; 'A Dead Hero'; 'The Jaguar'; 'Puma and Macaw' (1900); 'Wounded Leopard'; 'Tigers Drinking,' owned by Henry Frick, New York; 'Ceylon Leopards.' In 1905 he was made a Royal Academician. Consult Baldry, 'J. M. Swan, R.A.' (New York 1905).

SWAN, Joseph Rockwell, American jurist: b. Westernville, N. Y., 28 Dec. 1802; d. Columbus, Ohio, 18 Dec. 1884. He removed to Columbus, Ohio, in 1824 and was there admitted to the bar. He was prosecuting attorney in 1830–34, and judge of the Court of Common Pleas (1834–45). In 1854 he became judge of the Supreme Court and 1859 rendered his most important decision. The United States District Court in Ohio had sentenced a prisoner for violating the Fugitive Slave Law. Under a writ of habeas corpus the Supreme Court of the State sought to set aside the sentence, but it was sustained by Judge Swan, who declared that the State could not reverse the decisions of the United States courts. His publications include 'Treatise on Justices of the Peace and Constables in Ohio' (1836); 'Statutes of Ohio' (1841); 'Manual for Executors and Administrators' (1843); 'Practice in Civil Actions and Proceedings at Law in Ohio and Precedents in Pleading' (1845); 'Swan's Pleadings and Practice' (1851); 'Commentaries on Pleadings under the Ohio Code' (1860).

SWAN, Sir Joseph Wilson, English inventor: b. Sunderland, 31 Oct. 1828; d. 1914. He invented the carbon process of making autotypes, and with Woodbury introduced Woodburytype. To him also is due the invention of the dry plate, which has revolutionized photography. His name is, however, best known in connection with a form of incandescent electric lamp devised by him, which was the earliest in date of the many electric lamps now in use. His other inventions include a miner's electric safety-lamp, and various improvements in photo-mechanical printing and electro-metallurgical deposition. He was a knight of the Legion of Honor, and in 1898–99 he was president of the Institution of Electrical Engineers. He was knighted in 1904.

SWAN, a sub-family (*Cygninæ* or *Oloridæ*) of the duck family, characterized by great size and length of neck. The swans have the legs (tarsi) short and reticulated, the front toes being strongly webbed, while the hind toe is not webbed, and has no lobe; and the loral region (between the eyes and the bill) is naked.

In the water the swans are the type of grace and beauty of figure, the long arched and flexible neck, the elevated wings, and their buoyancy and skill in turning and gliding over the surface, all contributing toward this effect. On land, however, the very posterior position of the legs renders them awkward and slow. Unlike the fussy ducks and geese there is a calmness and dignity about the behavior of swans which has always excited admiration and has caused these birds to figure much in poetic literature. Swans are generally quiet birds and some appear to be constitutionally mute, but most of them possess the most powerful and sonorous voices, though none of the musical ability attributed by poets to their death song. These great vocal powers are due to the sounding apparatus developed by the coiling of the greatly elongated trachea within the sternum, much after the fashion of the same organ in certain cranes (q.v.). Not over 10 clearly marked species of true swans are known the world over and nearly every part of the world has its one or more species, for these birds are strong of wing and wide ranging. No species, however, breeds in Africa. They are arranged in four or five genera.

The North American swans belong to the genus *Olor,* distinguished from the typical *Cygnus* by purely technical characters. The two species, the whistling swan (*O. columbianus*) and the trumpeter swan (*O. buccinator*) are much alike in appearance, being chiefly white, but the latter is the larger, attaining a length of five feet and a spread of eight feet. And the tail contains 24 quill feathers, whereas the whistling swan has but 20. The former is the more widely distributed and the one usually seen on both the Atlantic and Pacific coasts, while the trumpeter swan is most characteristic of the Mississippi Valley, up and down which it migrates, breeding in the upper parts and wintering along the Gulf coast. The whistling swan breeds only in the far north entirely beyond the limits of the United States. It winters in considerable numbers in Chesapeake Bay and the sounds of North Carolina. They associate with wild geese and like these feed largely upon water plants. On account of their large size they are considered great prizes among gunners, but the younger birds, distinguished by the duskiness of their plumage and their less brazen voices, are preferred for table use. The nests are on the ground and are lined with dried grass and down. The two to five eggs are about four and one-half inches long and of a yellowish-white color. Except for the differences resulting from its distribution and fresh-water habitat the habits of the trumpeter swan are essentially similar.

The common domesticated white or mute swan (*Cygnus olor*) is a native of Europe, Asia and Africa. Those of Great Britain are all of the introduced domesticated variety. The swan has, from a very early date, been especially protected by both legal and regal interference. In Henry VII's reign the theft of a swan's egg was deemed an offense punishable by a year's imprisonment; and the theft of a swan itself was very severely punished. Swans at a prior date were declared to be exclusively "royal" or "king's" property; and no subject was entitled to hold possession of these birds, save under special favor from the sovereign. To such subjects as possessed the permission to keep swans a special "swan" mark was attached, and this mark was cut on the bill of the birds as a distinctive badge of ownership. The process of marking is known as "swan-upping" or "hopping," and the ceremony in the Thames on the part of the Crown and of the Dyer's and Vintners' companies takes place on the first Monday in August. At the present time but few swanneries remain, but in some places cygnets are carefully raised and bred for the market and a few of these birds are kept for ornamental purposes in most large parks. Several other wild species occur in the Old World and one true swan in South America. The black swan (*Chenopsis atrata*) is an Australian species, first discovered in 1698; the general plumage is black, the bill being deep red, the primary wing-feathers white and the trachea does not enter the sternum. It is well known in the United States as an ornamental bird. Consult Beebe, C. W., 'The Swans' (in 'Tenth Annual Report of the New York Zoological Society,' New York 1906); Stejneger, 'Proceedings U. S. Nat. Mus.' (Washington 1882); Newton, 'Dictionary of Birds' (Vol. IV, London 1896); Grinnell, 'American Duck Shooting' (New York 1901).

SWAN, Knight of the, according to a legend of the lower Rhine, a knight who comes from an unknown country in a boat drawn by a swan, delivers a prince's daughter from her hated suitor and marries her himself, and afterward is obliged to leave her since in spite of his forbidding her to do so she inquires and learns his origin, her ignorance of which is the sole condition of his remaining with her. This fable, which has parallel forms in the earliest mythologies, is varied in many ways by the poets and story-tellers of the Middle Ages. Thus in the French variant 'Roman du Chevalier au Cygne,' Godfrey de Bouillon is the hero of the story. This version is followed by the unknown author of the tale 'Lohengrin'; while Conrad of Würzburg in his poem, 'The Swan Knight,' places the incident in the days of Charlemagne. Consult Hagen, 'Die Schwanensage' (1845); Müller, 'Die Sage vom Schwanen'; Jaffray, 'Two Knights of the Swan' (New York 1910); Newell, W. W., 'Legend of the Holy Grail' (Cambridge, Mass., 1902).

SWAN, Order of the, an order of knighthood created in 1440 by the Elector Frederick II of Brandenburg. Its headquarters were in a monastery on a hill near Brandenburg and in Ansbach. It was composed of members of the nobility and its object was to encourage more enthusiastic homage to the Virgin Mary, and perseverance in works of mercy. The order was abolished at the time of the Reformation, but was revived by Frederick William IV of Prussia 24 Dec. 1843 in the form of a free association of men and women of all ranks and creeds for the purpose of alleviating the moral and physical misery of others. Consult Hanle, 'Urkunde und Nachweise zur Geschichte des Schwanenordens' (1874).

SWAN MAIDEN, The. See VALKYRIES.

SWAN RIVER. See AUSTRALIA, WEST.

SWANEVELT, svän'ę-fělt, **Hermann,** Dutch painter: b. Woerden, 1618; d. Rome, 1690. He set out for Italy when very young, carefully studied the scenery of its beautiful districts and, captivated by the pictures of Claude Lorraine, became a scholar of this famous master. He equaled, or perhaps surpassed, his master in his figures both of men and animals, and will always hold a first place among the greatest of landscape-painters. His etchings, 116 in number, partly of subjects of his own invention and partly of actual scenery, are very much admired. His pictures, even during his lifetime, brought very high prices.

SWANK, James Moore, American economist: b. Westmoreland County, Pa., 12 July 1832; d. 21 June 1914. He founded the Johnstown *Tribune*, 1853; was chief clerk Agricultural Department, 1871–72; secretary American Iron and Steel Association 1873–85. He is the author of 'History of Iron in all Ages'; 'Iron Making and Coal Mining in Pennsylvania,' and over 50 tracts on the tariff question.

SWANSEA, swŏn'sē, or **ABERTAWE,** Wales, an important seaport, capital of the county of Glamorgan, on the right bank of the river Tawe, at its mouth in Swansea Bay, 35 miles west-northwest of Cardiff. The town contains a fine town-hall with a Corinthian façade; the Royal Institution of South Wales, including a library, museum, etc.; a large building in which are housed the public library, art gallery and schools of science and art; a grammar, technical and other schools; the general hospital, a deaf and dumb institution, a blind asylum, etc.; remains of an ancient castle dating in its present form from the 16th century, though first built in 1099; and several public parks. The harbor is an excellent one with ample modern docks. The staple industries are the smelting and refining of copper, gold, silver and pyrites, which are imported for the purpose from many countries, the manufacture of tinplate and the working of iron, steel, zinc, nickel, lead and other metals. Chemicals, patent fuels and alkali are also made in considerable quantity, and there are flour-mills, shipbuilding yards, etc. Swansea is also a leading seaport, its imports average annual value $22,000,000, being chiefly the raw material for its metallurgical industries, wheat and other grains, sugar and timber; and its exports average annual value $30,000,000, mainly coal, coke and patent fuel, iron and iron and steel manufactures, wrought and unwrought copper and chemical products (dyestuffs, sulphate of copper and carbide of calcium). The vessels annually at the port have an average total tonnage entered and cleared of about 5,000,000 tons. Swansea has municipal tramways worked by electricity, and the town is served by the Great Western, London and North-Western, Midland and some local Welsh railways. The first charter of the borough was granted by King John, and subsequent charters were conferred by Henry III, Edward II, Edward III and Cromwell. The copper industry of the town began to attain importance early in the 19th century, and since about 1830 the town has rapidly advanced in consequence of the development of this and other industries. Pop. 114,663.

SWANSON, Claude Augustus, American senator: b. Swansonville, Va., 31 March 1862. He was graduated at the Randolph-Macon College in 1885 and at the University of Virginia in 1886, afterward engaging in law practice at Chatham, Va. He served in Congress as a Democrat in 1893–1905, when he resigned after re-election, and in 1906–10 he was governor of Virginia. In 1910 he was appointed United States senator to fill the unexpired term of John W. Daniel, and was subsequently elected to that office for the terms 1911–17 and 1917–23.

SWANTON, John Reed, American ethnologist: b. Gardine., Me., 19 Feb. 1873. He was graduated at Harvard University in 1896, later studied at Columbia University and took his Ph.D. at Harvard in 1930. He has been ethnologist of the Bureau of American Ethnology, Washington, since 1900. Author of 'Contributions to the Ethnology of the Haida' (1905); 'Haida Texts and Myths' (1905); 'Social Conditions, Beliefs and Linguistic Relationship of the Tlingit Indians' (1904–05); 'Tlingit Myths and Texts' (1909); 'Haida' (1911); 'Indian Tribes of the Lower Mississippi Valley and the Adjacent Coast of Mexico' (1911), etc. He is joint author of 'Dictionary of the Biloxi and Ofo Languages' (1912); 'Anthropology in North America' (1915), etc.

SWARTHMORE (swârth'mōr) **COLLEGE,** located at Swarthmore, Pa. It was founded by the liberal (or Hicksite) body of the Society of Friends, and was first opened in 1869. The main building was destroyed by fire in 1881, but was immediately rebuilt. The college now confers regularly but one baccalaureate degree, that of A.B. This was the original custom until 1874, when the practice of conferring the three degrees of A.B., B.S. and B.L., and the special degree of bachelor of science in civil engineering was adopted; in 1903 the college returned to its first practice. Courses in engineering and mechanic arts are offered, and provision is made for a special course leading to the degree of bachelor of science in civil engineering. The A.B. course includes certain prescribed studies, one major study in any one department in which three full years of college work must be completed, and electives to complete the required number of hours. The prescribed studies include English, Bible study, history or economics, at least one language and one science, and mathematics, or engineering. In the departments of biology, chemistry and physics courses are planned to prepare for the study of medicine. The degrees of master of arts and civil engineer are conferred for graduate work. Swarthmore has been from the first a coeducational college, being the second institution east of the Alleghany Mountains to offer instruction to men and women on absolutely equal terms. Though it is a small college, and not a university, it is especially well equipped for an institution of its size, especially in the science and engineering departments. It has a campus comprising more than 200 acres, bordered by the gorge of Crum Creek, and including the farm on which Benjamin West, the artist, was born. The chief buildings are Parrish Hall (the main building), Science Hall, the observatory, the two gymnasiums, the president's house and residences of the professors, Wharton Hall (a new dormitory). There are two fellowships and 17 scholarships. The productive funds amount to about $1,600,000 and the annual income to $170,000, the library contains 35,000 volumes, including the Friends' Historical Library. The students number 450 and the faculty about 50.

SWASTIKA, a symbol of the sun in the nature-religions of Aryan races from Scandinavia to Persia and India; and similar devices occur in monumental remains of the ancient Mexicans and Peruvians, and on objects exhumed from prehistoric burial mounds within the limits of the United States. The Swastika consists of a Greek cross, either enclosed in a circle the circumference of which passes through its extremities ⊕, or with its arms bent back thus 卐, and it is found invariably associated with the worship of the Aryan sun-gods (Apollo, Odin), it is believed to represent the sun. Consult d'Alviella, Eugène Goblet, 'La migration des symboles' (Paris 1891); de Milloué Léon, 'Le Svastika' (in *Annales du Musée Guimet,* Vol. XXXI, Paris 1909); Wilson, Thomas, 'The Swastika, the Earliest Known Symbol and its Migration' (in United States National Museum, *Annual Report,* 1894, Washington 1895).

SWAT, swät, India, a territory or district of the Northwest Frontier Province, occupying the valley of the Swat River, north of Peshawar and south of Chitral. It was well known to the ancients, but seldom visited by Europeans until the uprising of the frontier tribes in 1895. It is a narrow valley between lofty mountains, and inhabited by industrious, liberty-loving Afghan tribes. Pop. about 40,000.

SWATOW, swä-tow', China, a treaty port in the province of Kwang-tung, situated at the mouth of the Han River, 175 miles northeast of Hongkong. The total trade of the port amounts to nearly $34,000,000 annually. The chief exports are sugar, tobacco, cloth and fruits. The port was opened to foreign trade in 1858. The imports reach annually the sum of about $30,000,000, and the exports to $11,000,000. Pop. 66,000.

SWAYNE, swān, **Noah Haynes,** American jurist: b. Culpeper County, Va., 7 Dec. 1804; d. New York, 8 June 1884. He was admitted to the bar in 1823; settled in Coshocton, Ohio, in 1825; and was prosecuting attorney of the county in 1826–29. In the latter year he became a Democratic member of the legislature. He was United States district attorney for Ohio in 1831–41. He was an associate justice of the United States Supreme Court in 1862–81. In the latter year he resigned owing to advanced age.

SWAZILAND, swä'zē-lănd, South Africa, a native state between the Drakensberg and Lobombo ranges, on the borders of the Transvaal. Its surface is mountainous but fertile, and it is thought to contain rich gold and coal deposits. It possesses fine prairies, which offer fine pasturage, especially in winter. There are also extensive forests which contain fine timber — a rarity in South Africa. Water is plentiful, the climate is healthful. The Swazis are a Zulu tribe and were subject to the intrigues of Great Britain and the Transvaal. The Boers obtained supremacy in 1895, which passed with their conquest and annexation by England in 1902. Authority passed to the high commissioner of South Africa in 1906. The Roman-Dutch law is in force. The British resident commissioner is located at Mbabane. Area, 6,536 square miles. Pop. 107,117.

SWEABORG, svä'ä-bŏrg, or **SVEABORG,** Finland, a fortress and naval arsenal, three miles southeast of Helsingfors, which it defends, on a series of islands in the Gulf of Finland. The fortifications are so important as to entitle the islands "The Gibraltar of the North." The principal works occupy five islands which are connected by bridges. The island of Bärgo contains the chief military departments, arsenal and school of marines; the shipping docks hewn in solid rock, powder magazine and the monument to the Swedish Field-Marshal Ehrensvärds, who erected the fortifications. The strongest fort stands on the island south from here and is called Gustavsfard. Sweaborg was taken by the Russians in 1808; in 1855 it was bombarded by the French and English allied troops. After the revolution in Russia in 1917 Sweaborg was taken by the Finns, and upon the establishment of Finland as an autonomous state it was incorporated therein. Civil pop. about 1,000.

SWEARING, Profane, the use of oaths in a light and familiar manner by way of asseveration or emphasis. As popularly understood, «profane swearing» involves also many terms of a gross and obscene character. Profane swearing and cursing are made punishable in England by the Act of 19 Geo. II, ch. xxi, which prescribes a graded tariff of penalties for offenders according to their social rank: for each profane oath or curse a laborer, soldier or sailor incurs a penalty of a shilling; other persons under the rank of gentleman two shillings; a gentleman or any one above that rank, five shillings. In several of the States of the American Union profane swearing is variously declared punishable by the statutes. See BLASPHEMY.

SWEAT. See PERSPIRATION.

SWEATMAN, Arthur, Canadian Anglican archbishop: b. London, England, 19 Nov. 1834; d. Toronto, Canada, 24 Jan. 1909. He studied at the University of London and was graduated at Cambridge University in 1859. He was ordained priest in 1860 and in 1865 he removed to Canada where he became head master at Hellmuth Boys' College, London, Ontario, a position he occupied in 1865–72 and 1874–76. He was chaplain to the bishop of Huron, and secretary to the Synod of the diocese of Huron in 1872–79, and held other offices in the Church. He became canon of the cathedral at London, Ontario, in 1875 and was made archdeacon later in that year. In 1879 he was appointed bishop of Toronto, and in 1907 he became archbishop, metropolitan and primate of all Canada.

SWEATING SICKNESS, a febrile epidemic disease of extraordinary malignity which prevailed in Europe, particularly in England, at different periods toward the end of the 15th century and the beginning of the 16th. It appears to have spared no age nor condition, but is said to have attacked more especially persons in high health, of middle age and of the better class. Its attack was very sudden, producing a sensation of intense heat in some particular part, which heat afterward overspread the whole body, and was followed by profuse sweating, attended with insatiable thirst, restlessness, headache, delirium, nausea, an irresistible propensity to sleep and great prostration of strength. The patient was frequently carried off in one, two or three hours from the eruption of the sweat. It seems to have first appeared in the army of the Earl of Richmond upon his landing at Milford Haven in 1485, and soon spread to London. This body of troops had been much crowded in transport vessels, and was described by Philip de Comines as the most wretched that he had ever beheld, collected probably from jails and hospitals, and buried in filth. It broke out in England four times after this, in 1506, 1517, 1528 and 1551. The process eventually adopted for its cure was to promote perspiration and carefully avoid exposure to cold. The violence of the attack generally subsided in 15 hours. The disease is endemic in parts of Picardy, France, and in Italy, being known in the latter country as miliary fever. In 1906 there was an epidemic in France. It appears to be allied to influenza. Compare the epidemic of the latter disease in the armies operating in Picardy in 1918, whence it spread throughout the world. Consult Hecker, J. F. K., 'Epidemics of the Middle Ages' (London 1859) and Osler, W., 'Modern Medicine' (Philadelphia 1914).

SWEATING SYSTEM. See FACTORIES AND FACTORY INSPECTION; FACTORY SYSTEM, THE.

SWEDBERG, svād'bĕrg, afterward **SWEDENBORG,** swē'dn-bôrg, Swed. svä'dĕn-bŏrg, **Emanuel,** Swedish theologian: b. Stockholm, 29 Jan. 1688; d. London, 29 March 1772. His father, Jesper Swedberg, was a chaplain and court-preacher to the king, Charles XI. Swedberg's paternal ancestors had been opulent miners in the province of Dalecarlia, and it is also claimed that the heroic blood of Engelbrecht, who liberated Sweden from Denmark in 1434, flowed in his veins. On the side of his mother, Sarah Behm, he descended from Gustavus Wasa, king of Sweden from 1523 to 1560. The name «Swedberg,» as well as Swedenborg, which was given to the family later when they were ennobled, was derived from «Sveden, by which name the homestead was called, and which means a clearing in the forest made by fire.

About all that is known of Swedenborg's childhood and early youth is contained in his autobiographical statements made in two letters, one to Dr. G. A. Beyer, a celebrated clergyman of Sweden, the other to Rev. Thomas Hartley, of the Established Church in England. In the former he writes: «From my fourth to my 10th year I was constantly engaged in thought upon God, Salvation and the spiritual ills of mankind; and several times I revealed things at which my father and mother wondered; saying, that angels must be speaking through me. From my sixth to my 12th year I used to delight in conversing with clergymen about faith, saying that the life of faith is love, and that the love which imparts life is love to the neighbor; also that God gives faith to every one, but that those only receive it who practise that love. I knew of no other faith at that time, than that God is the Creator and Preserver of Nature, that he imparts understanding and a good disposition to men, and several other things that follow thence. I knew nothing at that time of that learned faith which teaches that God the Father imputes the righteousness of his Son to whomsoever, and at such times, as he chooses, even to those who have not repented and have not reformed their lives. And had I heard of such a faith, it would have been then, as it is now (1769), above my comprehension.»

In the second letter he says: «In the year 1710 I went abroad. I proceeded first to England, and afterward to Holland, France and Germany, and returned home in the year 1714.

In the year 1716, and also afterward, I had many conversations with Charles XII, king of Sweden, who greatly favored me, and the same year offered me an assessorship in the College of Mines, which office I filled until the year 1747, when I resigned it, retaining, however, the official salary during my life. My sole object in tendering my resignation was that I might have more leisure to devote to the new office to which the Lord had called me. A higher post of honor was then offered me, which I positively declined, lest my heart should be inspired with pride. In the year 1719, I was ennobled by Queen Ulrica Eleanora, and named Swedenborg; and from that time I have taken my seat among the nobles of the rank of knighthood, in the triennial Diet of the Realm. I am a Fellow and Member, by invitation, of the Royal Academy of Sciences in Stockholm; but I have never sought admission into any literary society in any other place, because I am in an angelic society, where such things as relate to Heaven and the soul are the only subjects of discourse; while in literary societies the world and the body form the only subjects of discussion.» In the same letter he speaks of his special mission as follows: «I have been called to a holy office by the Lord Himself, who most mercifully appeared before me, His servant, in the year 1743; when He opened my sight into the spiritual world, and enabled me to converse with spirits and angels, in which state I have continued up to the present day (1769). From that time I began to print and publish the various arcana that were seen by me or revealed to me, concerning Heaven and Hell, the state of man after death, the true worship of God, the spiritual sense of the Word, besides many other most important matters conducive to salvation and wisdom. The only reason of my journeys abroad has been the desire of making myself useful, and of making known the arcana that were entrusted to me. Moreover I have as much of this world's goods as I need, and I neither seek nor wish for more.»

In the year 1709 Swedberg finished his studies at the University of Upsala. In September 1710 he went to London, where for two years he studied astronomy, chemistry, physics, mathematics and other sciences. Then he journeyed through Holland to Paris and after a full year of studies and researches there proceeded to Germany in pursuit of knowledge at the universities, returning to Sweden in 1715.

During the following five years Swedberg wrote 21 separate treatises and works on various scientific and practical subjects. Among these were descriptions of his own discoveries and inventions in science and the mechanic arts, as the construction of air-pumps, ear-tubes and flying machines, improvement in mining and smelting ores, the building of sluices and canals, the nature of fire and color, the manufacture of salt, the regulation of the coinage, and various astronomical, geological and mathematical subjects, besides an important and original little work on 'Tremulation,' being a theory of sensation in the human body. Up to this time Swedberg had written in Swedish for the most part, but afterward all his works were published in the Latin language.

In 1719, as above mentioned, the family was ennobled and took the name Swedenborg. In 1721 Emanuel Swedenborg set forth again on a Continental tour of 15 months, publishing the same year at Amsterdam treatises on 'Chemistry,' on 'Iron and Fire,' and astronomical and mechanical subjects. At Leipzig in 1722 he published his 'Miscellaneous Observations on Natural Things.' Returning to Stockholm he devoted the next 11 years to his duties in the College of Mines, his office in the Diet, and in elaborating a great work on the theory of creation or cosmogony which he published at Leipzig in 1734 while on a third foreign journey. This treatise, the 'Principia,' forms Part I of his 'Philosophical and Metallurgical Works,' of which Parts II and III treat of 'Iron' and 'Copper' respectively. The same year he published 'Outlines of a Philosophical Argument on the Infinite, etc.' The next year was devoted to duties at home, and the preparation of an extraordinary work on the 'Brain.' In 1736 he left Sweden for a fourth time, traveling by way of Hamburg and Amsterdam to Paris, where he remained through the following year, proceeding to Rome in 1738. The next year he returned to Paris and in 1740 published at Amsterdam the 'Economy of the Animal Kingdom, Part I.' The next year he published at the same place the second part of this remarkable work on the composition, essence and circulation of the blood; the arteries and veins, the heart and brain; the circulation in the fœtus, etc. Swedenborg's ruling aim and end in all his work now was to discover, if possible, the soul. Says he: «Bending my course inward continually, I shall open all the doors that lead to her, and by Divine permission, contemplate the soul itself.»

'The Animal Kingdom,' a great work elaborating still further a rational and philosophical view of human anatomy, was published in The Hague in 1744. It is notable that many of the doctrines in these books, discoveries and conclusions original with Swedenborg, have since been confirmed by modern investigation, but the honor has been attributed to others. Among such anticipations may be mentioned, the true office of the lungs; the animation of the brain, and of its coincidence, during formation, with the systole and diastole of the heart, and after birth, with the pulmonary respiration; the vitality of the blood, etc.

In 1745 appeared at London his 'Worship and Love of God,' the last of his publications previous to the opening of his spiritual sight, when he became a seer and revelator. He records three manifestations of the Lord to him calling him to his new office. The first was in 1743 in Amsterdam during a «preternatural sleep.» The second was at Delft in Holland in 1744 when, as he says, the Lord manifested himself in person and spoke with him. «It was a countenance with a holy expression, and such that it cannot be described; it was smiling, and I really believe that his countenance was such during his life upon earth.;

The third appearance of the Lord to him, Swedenborg relates, was in 1745 in London when the Lord manifested himself again in person, commissioning Swedenborg and calling him to the office of revealing the Doctrine of the New Jerusalem. «From that day,» he says, «I gave up the study of all worldly science and labored in spiritual things, according as the Lord commanded me to write.» Then followed two years of preparation and illumination before it may be said that he was gifted with a full state of inspiration and a perception of the inmost or celestial sense of the Word.

From 1748 to 1756 the 'Arcana Cœlestia' in eight vols., quarto, was published in London. This work, the first of Swedenborg's Theological and Doctrinal series, sets forth the internal sense of Genesis and Exodus as it was revealed to him, he declares, immediately by the Lord alone. Then followed (1758) 'Heaven and Hell,' describing the spiritual world and the life of man after death, as well the happy state of the blessed as the miserable lot of the infernal. In the same year appeared 'The White Horse'; 'The Earths in the Universe'; 'The Last Judgment'; 'The New Jerusalem and its Heavenly Doctrine.' During 1757-59 Swedenborg was engaged upon an explanation of the spiritual sense of the Apocalypse, which work he left uncompleted after writing 1,992 pages. It was published in 1785-89. 'The Last Judgment' describes that event itself which, as he testifies, Swedenborg witnessed in the spiritual world in 1757. 'The New Jerusalem and its Heavenly Doctrine' teaches that the New Jerusalem means the New Church now being established both in the natural and spiritual worlds, the doctrine of which is called Heavenly because it is received by angels and will be received on earth by men of angelic minds. In 1763 appeared 'The Four Doctrines of the New Jerusalem: The Lord, The Sacred Scripture, Life and Faith,' which as revealed in the Word are fundamental teachings of the Church; and 'The Divine Love and Wisdom' treating of the Lord as the Sun of heaven, the Creator of the Universe; of the nature of the Divine and its method and order in bringing ultimate finite and human creatures into existence and being. In 1764 'The Divine Providence' was published, showing how the created universe is perpetually sustained and setting forth the laws of God by which he governs man in even the least things of his life to eternity. 'The Apocalypse Revealed' (1766), discloses the internal and real meaning of the «Apocalypse» or «Revelation,» describing the New Jerusalem as to its quality of life among all who receive the Heavenly Doctrine in this world and by obedience to its teachings are inaugurated by the Lord into his New Church. 'Delights of Wisdom Concerning Conjugal Love' (1767-68) setting forth the laws of spiritual and eternal marriage which must exist between the souls of wedded consorts. Disclosing the insanities and horrors of adultery together with a prescription of laws for the preservation of the conjugal quality in the mind, in the heart and in the life of the man who is unmarried but who regards marriage as a heavenly and blessed estate and condition. 'The Brief Exposition of the Doctrine of the New Church' (1768-69) wherein is shown the utter variance of the theological dogmas prevailing throughout what is known as the Christian world, both in the Roman Catholic and Protestant churches, from the genuine doctrine of the Scriptures. In the preparation of this work Swedenborg had especially in view the clergy of the Christian church and he distributed the book to them and to theological seminaries in Europe. The last and crowning work of this series of philosophical and doctrinal expositions of the Internal Sense of the Word and of the nature of the Spiritual World is 'The True Christian Religion or the Universal Theology of the New Church' (1771). In this book is presented a general view of the Doctrines of the New Church fully explained together with wonderful accounts of things seen and heard in the Spiritual World related by Swedenborg as a witness thereof.

Among the writings of Swedenborg published since his decease may be specially mentioned 'The Spiritual Diary' (1748-65), comprising a chronicle in the form of notes about persons and things in the Spiritual World, memorable for one reason or another, which he either met or was in some way concerned with on account of his mission.

In another posthumous little work, 'The Consummation of the Age,' etc., Swedenborg explains that now is the end of the Christian Church, the Second Advent of the Lord and the beginning of the New Church which is signified by the «New Jerusalem» in John's Apocalypse.

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SWEDEN, or SVERIGE, svā'rē-gĕ, a northern European state, forming with Norway (q.v.) a united kingdom, occupying the whole of the peninsula known in ancient times by the name of Scandinavia. Sweden is situated between lat. 55° 20′ and 69° N.; and long. 11° 40′ and 24° E.; and is bounded north and west by Norway; southwest by the Skager-Rack, Kattegat and Sound; south by the Baltic; east by the Baltic and the Gulf of Bothnia; and northeast by the Tornea and its affluent the Muonio, separating it from Finland. In addition to the mainland it has a great number of islands, most of small dimensions, lying close to the coast. The largest, and also the most distant, is Götaland, or Gothland, in the Baltic.

Sweden consists of the three historical divisions of Swealand or Sweden proper in the middle, Götaland, or Gothland, in the south and Norrland in the north. For administrative purposes it is divided into läns or governments. The area is estimated at 173,035 square miles, of which 3,700 are occupied by the larger lakes;

the population in 1917 was estimated at 5,757,-566, of whom 2,817,950 were males and 2,939,616 females. The average density is 33.3 per square mile. For 1916 the total recorded births numbered 121,214; deaths, 77,683; and marriages, 35,156. The same year 10,571 persons emigrated, 7,268 going to the United States. The recent increase in population chiefly affected the larger cities. In 1917 Stockholm numbered 111,823 inhabitants; Göteborg, 191,535; Malmo, 35,783; Norrköping, 55,623; Kälsingborg, 35,-783; Gäfle, 36,623; Orebro, 34,453; Eskilstuna, 30,111, and Karlskrona, 28,556.

Between 1860 and 1916 the town population had risen from 434,519 to 1,617,116, showing an increase of from 11 per cent of the total population of Sweden in the first-named year to 28 per cent in 1916; and between 1840 and 1910 the number of persons dependent on commerce and industry had risen from 10.75 per cent to 45.39 per cent. At the present time the proportions are about equal.

Topography.— The coast-line, above 1,400 miles in length, is serrated rather than deeply indented; its bays and creeks, though very numerous, having neither the width nor tortuous lengths by which the fiords of Norway are characterized. The west coast is very rocky, but seldom rises so high as 30 feet. Along the south and southeast coast low shores alternate with precipitous cliffs, which, however, are of no great elevation. As above stated many islets are scattered near the shores, and these where they form the archipelago of Stockholm are especially numerous. The whole of the upper part of the shore of the Gulf of Bothnia consists of sandy alluvial deposits, which are brought down by the rivers in such quantities that they seem destined at no distant period to convert a large portion of the gulf into dry land. It would appear, however, that alluvium is not the only agent employed in carrying on this process of shallowing, since it has been proved that the whole coast of Sweden is continually rising, the rise being greatest in the north.

The interior of Sweden is by no means generally mountainous, and its surface has far less of a highland than of a lowland character. The most elevated portion of it commences in the west near the parallel of 62°, and is continued north along the frontiers of Norway, not so much in a continuous chain as in isolated mountain-masses rising from an elevated table-land, which, where loftiest, is at least 4,000 feet, and forms the base of several summits which rise more than 6,000 feet above sea-level, and owing to their high altitude are covered with perpetual snow. The two loftiest mountains, Sarjektjakko and Kebnekaisse, both in Swedish Lapland, attain a height of about 7,000 feet. Other lofty peaks are Sulitjelma and Sylfjellen, between lat. 63° and 67° on the Norwegian frontier. These mountains and their table-land slope east toward the Gulf of Bothnia, sending down numerous torrents, which in their course often expand and form chains of lakes and dreary swamps. The same slope is continued south of 62° N., but besides it there is a south slope which attains its lowest level near lat. 59° N., on the shores of the magnificent lakes which there stretch almost continuously across the country east to west. To the south of 59° N. the country is generally flat, though in many parts finely diversified. This region has several fertile and well-cultivated tracts, but a good deal of it is covered by barren sand or stunted heath, though interspersed with forests, green meadows and cornfields. What is called the Plain of Scania, occupying the whole of the south peninsula between the Sound on the west and the Baltic on the south and east, is generally a fine tract of land.

Hydrography.— The rivers and lakes are numerous; the latter in particular on a large scale, giving to the scenery of the country several of its grandest features. The rivers all belong to the basins of the Baltic Sea and the German Ocean. The former receives the far larger share. To it belongs the Torneå, which, rising in the Norwegian mountains, pursues its course south-southeast for nearly 290 miles, augmented by numerous large affluents, and falls into the northern extremity of the Gulf of Bothnia; the Luleå, Piteå, Skellefteå, and united Windel and Umeå, which flow precipitously southeast into the same gulf; the Angermann, which flows 230 miles, and in the lower part of its course becomes so wide and deep that vessels of 600 tons can ascend nearly 70 miles from the sea; and the eastern and western Dal, which, uniting their streams, receive the discharge of numerous lakes, and pursue a more circuitous course than usual in Swedish rivers. The principal rivers belonging to the basin of the German Ocean are the Klar and the Göta, the former of which, issuing from Lake Fämund, on the edge of the Doverfield Mountains, furnishes Lake Wener with its chief supply of water; while the latter, which may be considered only as its continuation, discharges it into the ocean. The lakes not only add to the beauty of the scenery but yield large supplies of fish, and both by their natural depth and the canals which have been cut to connect them are of vast navigable importance and furnish a long line of internal communication. In this way a direct channel has been opened from Göteborg on the west to Söderköping on the east coast, and communicating with the important towns of Wenersborg, Carlstad, Mariestad, Jönköping and Linköping. In the same manner the capital has been enabled to extend its connections with the interior. In general, however, the rivers are too rocky for navigation. The largest lake is Lake Wener (area, 2,014 square miles); the next in size Lake Wetter (715 square miles). Lake Mälar, better known than the other large lakes, from having the capital on its shores, is also remarkable for the number of islands which so crowd its surface that it is scarcely possible to find a square mile of open water. Hjelmar, which has both a natural and an artificial communication with Lake Mälar, has an area of 188 square miles.

Geology and Minerals.— The mines of Sweden are rising in importance as rapidly as new mining machinery is being introduced. In 1916 they already engaged 48,166 persons and yielded large quantities of iron and other ores, as well as lead, silver, copper and gold. In the year mentioned the amounts in tons were: iron ore, 6,986,298; coal, 414,825; zinc ore, 60,700; sulphur pyrites, 27.848; copper ore, 13,895; manganese ore, 8,894; silver and lead ore, 3,707; pig iron, 732,734; bar iron, 526,353. Besides, there were produced 230 tons of gold ore, 3,707 tons of silver and lead ore, and 8,894 tons of manganese ore. Almost the whole of the country is composed of gneiss, partially penetrated by granite. Patches of porphyry and greenstone, of Silurian rocks, of oolite, and of cretaceous rocks, appear in various localities. Iron not only occurs in beds of immense thickness, enclosed in strata of gneiss, but forms the principal mass of whole mountains. The most celebrated iron-mines are those of Danemora in län Upsala, where the iron worked is perhaps the best in the world, and is admirably adapted for steel. The quantity produced, however, is much smaller than in some other districts where the quality is also excellent.

Climate.— The climate of Sweden varies considerably with the latitude and elevation. There is hardly any spring or autumn intervening between the heat of summer and the cold of winter, but in the north the winter lasts for nine months, in the south only for seven. Speaking generally, the climate of Sweden, though modified by the proximity of the sea, so as to be milder in all respects than the interior of the northern parts of the Russian and Asiatic continents, is much more extreme than that of our own islands, even where the two countries are in the same latitude, and experiences greater degrees both of cold and heat. Hence at Stockholm the thermometer has been known to descend 26° below zero in January, and to rise in July to the almost tropical heat of 96.8°. The climate, however, is favorable to health, and no country furnishes more numerous instances of longevity.

Forestry and Flora.— Most of the public forests, covering an area of over 19,000,000 acres, belong to the government and yield considerable timber. In the very northern extremity of Sweden fine trees of pine, fir and birch are found. These, however, occupy only occasional patches, and the true forest-land must be considered as having its limit near 64°. Below this latitude, and chiefly in the central and southern parts of the kingdom, the forests occupy at least one-fourth of the whole surface, and sometimes stretch continuously for 80 miles in length by 20 miles in breadth. Many of these, however, consist of trees of stunted growth, available chiefly for domestic fuel or the supply of the smelting furnaces, and seldom of much use as timber. Forests in which oak and beech are the prevailing trees occur only in the south. The flora is of the post-glacial period, and of Finnish characteristics rather than of more southern and continental latitudes. Wild brier berries are plentiful.

Fauna.—Among the larger wild animals the wolf and bear abound in the forests, and often commit great ravages. The elk and deer are also found, but in more limited numbers. Of smaller animals the most destructive is the lemming, which at intervals of years descends in immense numbers into the low country and lays it waste. Among birds the most remarkable are eagles, capercailzies and woodcocks.

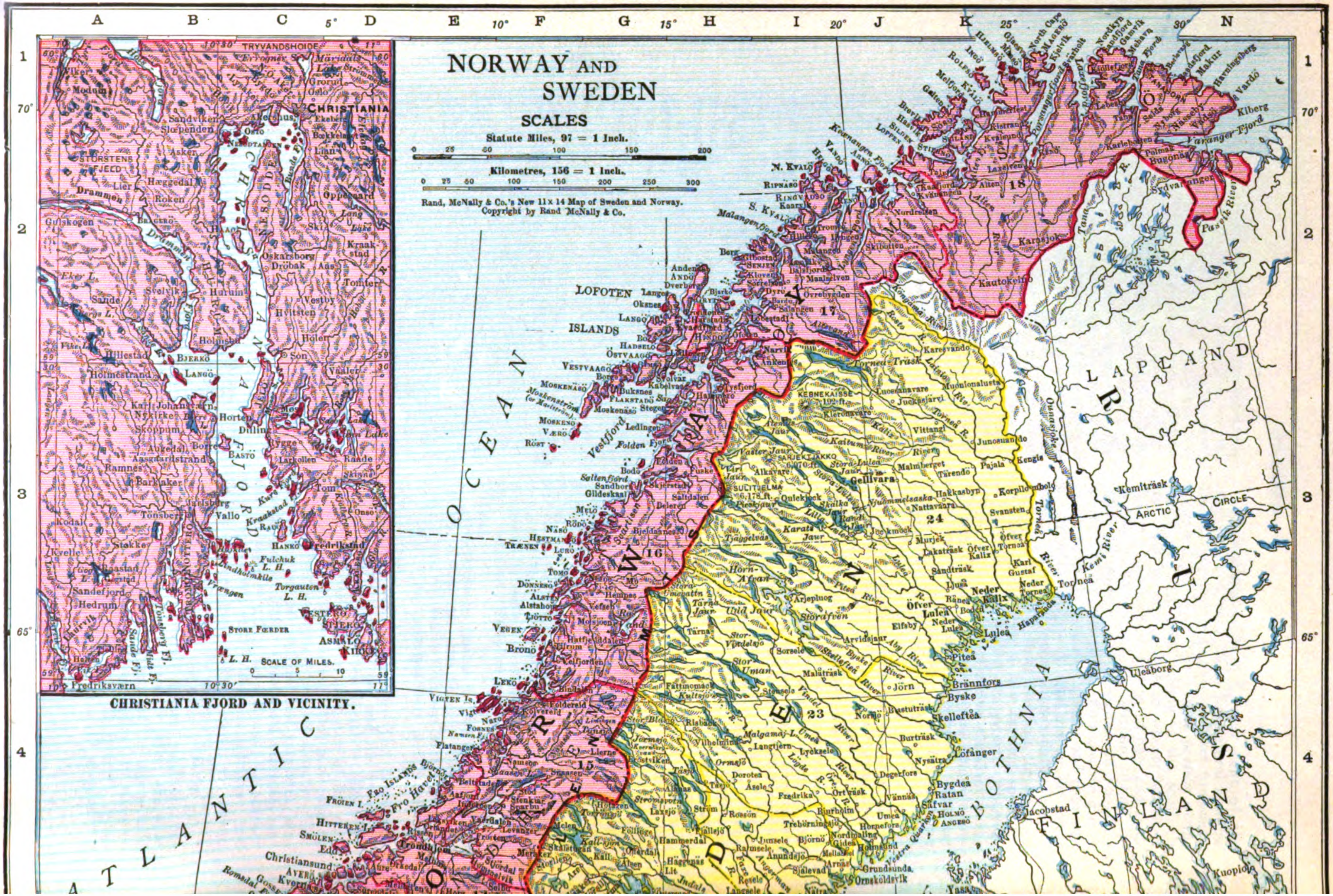
Fisheries.— The rivers and lakes are well stocked with salmon and trout, but the fisheries on the sea-coast have long ceased to be productive. Herrings, which used to visit the coast of the Baltic, have almost entirely disappeared, though large numbers of a fish resembling herrings are taken along the east coast. About 34,000 persons find employment in the fisheries.

Agriculture.—About 9.1 per cent of the total area is under crop, 3.3 in natural meadow and 54.7 per cent in forest, the latter furnishing a staple industry. Only a small portion of the arable land, and that mostly in the south, is favorable for the growth of wheat; but there is now a considerable export of oats and some of other cereals to Great Britain. Until recently the grain grown in Sweden did not suffice for domestic consumption. Potatoes are grown in almost all parts of the country, and form one of the main articles of food among the lower classes. The most important auxiliary crops are beet-root for sugar, hemp and flax, the latter of excellent quality; on a few favored spots tobacco, hops and madder are grown. Cherries, apples and pears are tolerably abundant in the southern districts. The principal domestic animals are cattle, sheep and reindeer. The last supply food and clothing. In 1917 there were 447,695 farms under cultivation, the products of which form a staple export.

Commerce, Manufactures, etc.— Of all the countries trading with Sweden, Great Britain is the one with which the largest amount of business is done, Germany coming next. The total value of the exports to all countries in 1916 was nearly $206,991,000, of which 5.3 per cent came from the United States, the exports to Great Britain amounting to half that amount. The total imports amounted to about $194,-811,000 (United States, 27.4 per cent). The principal exports are timber, iron, butter and wood pulp; imports, iron and steel, wrought and unwrought, coal, machinery, woolen and cotton goods. Next to agriculture the most important industry in Sweden is iron-mining. Other industries now of some importance are iron-founding and engineering, the spinning and weaving of cotton and woolen goods, paper-making, brewing, sugar-refining, match-making and glass-making. In 1917 there were 9,368 miles of railways, of which 3,268 miles belonged to the state. The public telegraph and telephone lines in 1917, 341,013 miles, belong wholly to the state. A tram ferry service operates between Trelleborg and Sasnetch in Prussia.

The mercantile marine in 1917 engaged 2,801 vessels of 1,128,435 tons burden. The tonnage entered and cleared in 1915 was 28,799,114 tons. Göteborg is the principal port and Stockholm comes next.

Weights and Measures.— The denominations of money are the *öre* and the *krona*, or crown (silver); 100 öre (each = .132*d.*) = 1 *krona* = 1*s.* 1⅛*d.* The greater part of the currency, however, is in paper, which is circulating in sums varying from 5 to 1,000 kronor. The metric system of weights and measures was introduced in 1883. Among old measures are the *skalpund* = .937 lb. avoirdupois; the *centner* (100 skalpund) = 93.7 lbs. avoirdupois; the *nyläst* (100 centner) = 83.67 cwts.; the *kanna* = 4.6 pints imperial; the cubic *fot* (10 kanna) = 5.76 imperial gals.; the cubic *aln* = 46 gals.; the foot (*fot*) = 11.689 inches imperial; the *tunneland* or acre = 1 acre 35 poles; the mile = 6.64 United States miles, and the square mile = 44 United States square miles; 10 *linier* = 1 *tum;* 10 *tum* = 1 foot; 10 feet = 1 *stöng* (= 9.74 United States feet); 10 *stänger* = 1 *ref;* 360 *ref* = 1 mile.



NORWAY AND SWEDEN
SCALES
Statute Miles, 97 = 1 Inch.
Kilometres, 156 = 1 Inch.
Rand, McNally & Co.'s New 11 x 14 Map of Sweden and Norway.
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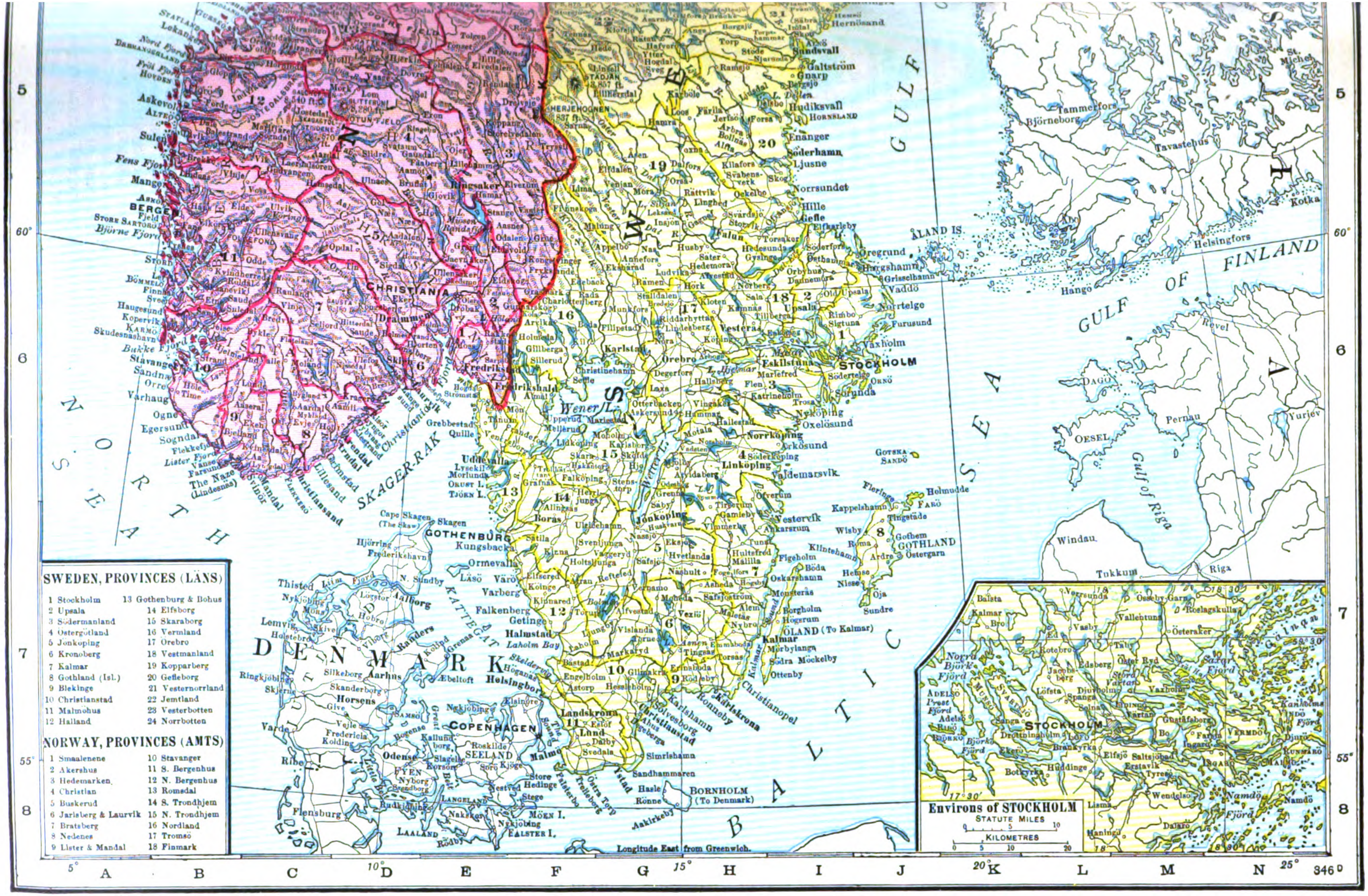
CHRISTIANIA FJORD AND VICINITY.
CHRISTIANIA
SCALE OF MILES.
LOFOTEN ISLANDS
ATLANTIC
OCEAN
BOTHNIA
LAPLAND
FINLAND
ARCTIC CIRCLE


SWEDEN, PROVINCES (LÄNS)
1 Stockholm
2 Upsala
3 Södermanland
4 Östergötland
5 Jönköping
6 Kronoberg
7 Kalmar
8 Gothland (Isl.)
9 Blekinge
10 Christianstad
11 Malmöhus
12 Halland
13 Gothenburg & Bohus
14 Elfsborg
15 Skaraborg
16 Vermland
17 Örebro
18 Vestmanland
19 Kopparberg
20 Gefleborg
21 Vesternorrland
22 Jemtland
23 Vesterbotten
24 Norrbotten
NORWAY, PROVINCES (AMTS)
1 Smaalenene
2 Akershus
3 Hedemarken
4 Christian
5 Buskerud
6 Jarlsberg & Laurvik
7 Bratsberg
8 Nedenes
9 Lister & Mandal
10 Stavanger
11 S. Bergenhus
12 N. Bergenhus
13 Romsdal
14 S. Trondhjem
15 N. Trondhjem
16 Nordland
17 Tromsö
18 Finmark
Environs of STOCKHOLM
STATUTE MILES
KILOMETRES
DENMARK
NORTH SEA
SKAGER-RAK
KATTEGAT
BALTIC SEA
GULF OF FINLAND
Gulf of Riga
CHRISTIANIA
STOCKHOLM
COPENHAGEN
GOTHENBURG
BERGEN
ÅLAND IS.
GOTHLAND
ÖLAND (To Kalmar)
BORNHOLM (To Denmark)
SEELAND
Longitude East from Greenwich.

Government.— The crown is hereditary in the male line. The king must be a member of the Lutheran Church, and has to swear fidelity to the laws of the land. His prerogatives consist of the right to preside in the high court of justice, to grant pardons, to conclude treaties with foreign powers, to declare war and peace, to nominate to all appointments civil and military and to veto absolutely any decree of the Diet or Parliament of the kingdom. He also possesses a power of administrative legislation. The princes of the blood-royal are excluded from all civil employments. The Diet consists of two chambers, which are both elected. The first or upper chamber consists of 150 members. The members are elected by 25 provincial landstings (or provincial assemblies) and the corporations of Stockholm, Göteborg, Norrköping, Malmö and Gefle. All the members must be above 35 years of age, and a property qualification is required to the taxed value of 50,000 kronor, or $13,885 in real property, or an annual income of 3,000 kronor or $830. They are elected for six years. The second chamber, elected on universal male suffrage for three years, contains 230 members, 150 elected by the rural population, being one for each 40,000 inhabitants; and 80 by the towns, being one for every 10,000 inhabitants. Members of both houses are paid 1,200 kronor or $335 per session of four months, in addition to traveling expenses. The election is by ballot on a basis of proportional representation. The executive power is in the hands of the king, under the advice of a council of state consisting of 11 members, eight of whom are departmental heads. The eight departments are: The Ministry of Justice, the Ministry of Foreign Affairs, the Ministry of War, the Ministry of Marine, the Ministry of the Interior, the Ministry of Finance, the Ministry of Education and Ecclesiastical Affairs and the Ministry of Agriculture. All the ministers are responsible for the acts of the government. The administration of justice is controlled independently of the government by the Justitie Kansler, appointed by the king, who acts for the Crown; and the Justitie Ombudsman, appointed by the Diet, who exercises a supervision over the law-courts.

Finances.—A large part of the revenue is derived from national property, including railways; the remainder from customs, excise, income tax, etc. The total estimated revenue for 1917 amounted to $107,000,000 and the expenditure was rather more. Part of the expenditure — civil, military and ecclesiastical — is defrayed from Crown lands and does not appear in the public accounts. The public debt is over $225,000,000. Sinking funds are provided for the payment of the debt.

The Riksbank, or National Bank of Sweden, belongs entirely to the state and is managed by directors elected for three years by the Diet, except one, the president, who is designated by the king.

Army and Navy.— The army has hitherto consisted of enlisted troops, a militia maintained by landowners and Crown domains, and conscription troops, drawn by annual levies; but it is now undergoing reorganization, which will take some years to complete, the result being an increase in numbers. Military service is compulsory. The active military force in 1916 consisted of 2,657 officers, 537 non-commissioned officers, 16,370 volunteers and a contingent of recruits. The total (including conscripts) was 83,000 men. The naval strength includes 15 armored coast defense vessels, four old torpedo gunboats, 10 torpedo-boat destroyers, 45 torpedo boats and submarines.

Ethnology.—Almost all the inhabitants of Sweden, with the exception of the Laplanders and Finns, found only in the north, are of Teutonic origin, and preserve the original features of the race in great purity, particularly in the central and southern provinces, where they are characterized by a tall, robust stature, light hair, blue eyes and light complexion. They are active and enterprising, and manifest a marked predilection for scientific pursuits. The state of morality is on the whole favorable. Heinous crimes are few, but a great number of minor delinquencies figure in the calendar and are evidently accounted for by the far too prevalent use of ardent spirits; but a considerable improvement in respect of the consumption of intoxicants seems to have taken place in recent times.

Religion and Education.—Almost all the inhabitants belong to the Evangelical Lutheran Church, which is the religion of the state, at the head of which is the archbishop of Upsala. Other religions are tolerated; but appointments in the public service can be held by Lutherans only. Education is gratuitous and compulsory. Primary education is well diffused. In 1916 there were 704,000 pupils in the elementary schools. The proportion of illiterates among recruits is 0.16 per cent. The University of Upsala (2,344 students in 1916) has done much to foster the cultivation of the higher departments of science and scholarship. There is also a university at Lund (1,341 students in 1916).

Language and Literature.— See SWEDISH LANGUAGE; SWEDISH LITERATURE.

History.— In the case of Sweden, as of many other countries, the industry of chroniclers has supplied details about ages with which they were unacquainted. These early chronicles, called Sagas, contain lists of kings at variance with each other, and stories of adventure of the kind to which the epithet heroic is usually applied, in which it is impossible to separate the fabulous from the historical. The first dynasty of Swedish kings, according to the legendary chronicles, belonged to a family called Ynglings, from their founder, Freyer Ingve, the reputed grandson of Odin, from whom the family claimed to be descended. The last of them was expelled by Ivar Widfadm, representative of the Danish family of the Skioldings, also descended from Odin, who united Sweden and Denmark under one rule. This event is referred to about 630 A.D. Near the end of the following century Ragnar Lodbrok, the reigning representative of this house, fell in battle on the English Coast, and his second son, Biorn Ironside, inherited Sweden, which was again separated from Denmark. Christianity was introduced under his grandson, Biorn II; but it was first established by Olaf, who reigned in the beginning of the 11th century (1001–26 A.D.). Until the beginning of the 12th century the chronicles contain rival lists of kings. From the first appearance of Sweden in history two rival tribes or confederacies, both of German origin, the Goths and the Swedes, contended for ascendency, and the confusion of the chronicles is probably due to the mingling of the lines of separate chiefs or monarchs reigning simultaneously in different districts. Emund Slemme, the last of the descendants of Biorn, was defeated and killed by the Goths in 1056, when the two nations were united under Stenkil, the Gothic monarch. On the death of his descendant, Inge II, in 1129, the Swedes raised a private individual, Sverker I, to the throne. To conciliate the Goths it was agreed that Erik, a descendant of Stenkil in the female line, should succeed Sverker, and that the two families should reign alternately. This arrangement, which seems to indicate that the power of the monarchs was merely that of leading chiefs, was continued, though the cause of much dissension and civil war, for several reigns. During the reign of Sverker the kingdom was divided into four dioceses (1152). Erik IX, called Saint Erik, succeeded about 1155. In his reign the Finns were conquered and converted to Christianity. Charles VII, son of Sverker, who succeeded about 1162, was defeated and killed by Knut Erikson, who succeeded in 1168. Sverker II, the son of Charles, was likewise defeated and killed by Erik X, son of Knut, who succeeded him in 1210. John I, son of Sverker II, and the last of his line, was succeeded in 1253 by Erik XI, the last of his, who died in 1260. Waldemar I, nephew of Erik, was raised to the throne by election, and founded the dynasty of Folkungar. Waldemar made a voyage to the Holy Land, leaving his brother Magnus regent, in 1272; on his return a civil war took place, but Waldemar abdicated in favor of Magnus in 1279 and failed in subsequent attempts to recover the throne. Magnus assumed the title of king of the Swedes and the Goths. His son, Birger II, in whose reign the conquest of Finland was completed, was expelled by the people in 1319, who chose his nephew, Magnus Snek, an infant, as his successor. He had already succeeded, in right of his mother, to the crown of Norway, which he gave to his son Haco in 1344. Scania, consisting of the two southern provinces, Malmöhus and Kristianstadt, which then belonged to Denmark, yielded to him in 1332, but he restored them on affiancing his son Haco to Margaret of Denmark. Magnus was deposed by the states and obliged to carry on a civil war for the crown with his son Erik, whose death again left him in possession of the kingdom; but aiming at absolute power, he was again deposed in 1365 in favor of his nephew, Albert of Mecklenburg, who had already been in possession, since 1363, of the supreme authority. Albert formed a league with Schleswig, Holstein, Mecklenburg and the Hanse towns against Denmark and Norway. He succeeded in driving the king of Denmark out of his dominions, but was defeated by the king of Norway, who besieged him in his own capital. Peace was concluded; but Albert, aiming, like his predecessor, at absolute power, made himself unpopular with his own subjects, who invited Margaret of Denmark and Norway, the Semiramis of the North, who had united the crowns of these kingdoms, to replace him. Albert, though supported by Holstein, Mecklenburg and the Hanse towns, was finally overcome and returned to Mecklenburg. Margaret succeeded in 1389, and by the union of Calmar the three kingdoms were formally united, each retaining its own constitution. Under the reign of her grandnephew Erik (1412–41) the Swedes revolted under Engelbrecht (1433). The union was renewed 1436, but both Danes and Swedes revolted against Erik, and Charles Knutson, grand mareschal of Sweden, was chosen regent. His rule proving oppressive, the joint crown was conferred in 1441 upon Christopher of Bavaria, nephew of Erik. On his death in 1448 Charles VIII (Knutson) was chosen king of Sweden. Norway also acknowledged him, but soon threw off the yoke. The severance of the union also produced a war with Denmark. Charles' reign was stormy and his subjects repeatedly revolted against him. He died in 1470. Christian I, king of Denmark, had been crowned king of Sweden in 1458 by the party opposed to Knutson, but on the death of Knutson his party chose his nephew, Sten Sture, administrator of the kingdom. Christian attempted to take possession of the kingdom, but was defeated and forced to retire. In 1483 John I, son of Christian, was recognized as king of Sweden in virtue of the Union of Calmar. The country was divided between the Danish and the national parties, but Sture contrived to hold the administration, and raised an army to drive the Russians out of Finland. In 1497 John invaded Sweden with a powerful army. Sture was completely defeated at Rotebro, 28 October. John conferred on him the government of Dalecarlia; but the Swedes again revolted and proclaimed him administrator in 1501. He died in 1503 and was succeeded in the administration by Svante Sture, who concluded peace with Russia and formed an alliance with the Hanseatic towns in order to prosecute the war with Denmark. The clergy and a large portion of the Senate favored the Danish alliance, but the peasantry were strongly opposed to it. Svante Sture died in 1512 and was succeeded by his son, Sten Sture the Younger. In the following year Christian II succeeded to the crown of Denmark. After the death of Sture, Gustavus Vasa raised the peasants of Dalecarlia, defeated the Danes, and, having embraced the Lutheran religion, was crowned king by a Protestant archbishop of Upsala in 1528. The Lutheran religion was formally established in Sweden in 1529. Christian II having been driven from Denmark, his title was acknowledged by his successor, Frederick I, and in 1544 was declared hereditary in his house. He died in 1560. His son, Erik XIV, reigned only eight years. Erik was one of the candidates for the hand of Queen Elizabeth of England and also of Queen Mary of Scotland.

To balance the power of the great nobles Erik created a secondary nobility and introduced the titles of count and baron into Sweden. A war with Russia, undertaken for the protection of the Teutonic order, resulted in the acquisition of Esthonia by Sweden; but war having subsequently broken out with Denmark was, in the confusion caused by the king's insanity, ill-conducted, and resulted in repeated disasters to the Swedes. John III, the brother of Erik, succeeded him on his deposition. By the peace of Stettin with Denmark, 13 Dec. 1570, Sweden renounced her claims to Norway, and surrendered a large part of Götland, including the west coast to Denmark. This treaty was made with a view to a war with

Russia. In this war the Swedes were successful in foiling the designs of Ivan IV on Livonia. Peace was concluded in 1582. John had married Catherine Jagellon, daughter of Sigismund, king of Poland, and through her influence endeavored to restore the Catholic religion in Sweden. A formidable opposition arising, headed by his brother Charles, and the queen dying, he abandoned the project. Sigismund, his son, was, however, brought up in the Catholic faith, and in 1587 he was elected king of Poland under the title of Sigismund III; John died 1592. Charles, Duke of Sudermania, who held the regency in the absence of his nephew Sigismund, endeavored to deprive him of his crown on the ground of his religion, but on the return of Sigismund with an army he was compelled to relinquish the government to him. Sigismund, on receiving the crown, returned to Poland, and left his uncle Charles regent. Charles again attempted to seize the crown and defeated Sigismund in the battle of Stängbro (September 1598). The states now conferred on him the title of hereditary prince, and insisted upon Sigismund sending his son to Sweden to be educated in the evangelical faith. Failing to comply, he and his posterity were excluded from the crown, and in 1604 Charles was acknowledged as king-elect of the Swedes, Goths and Vandals, and his son, Gustavus Adolphus, was recognized as his successor. He took the title of Charles IX. From these events arose a war with Poland, which was not terminated by a permanent peace till 1660. Wars also with Denmark and Germany continued till the end of Charles' reign. Charles IX died 1611, and was succeeded by his son, Gustavus Adolphus, then engaged in conducting the war with Denmark. One of the first acts of Gustavus was to select as his chancellor Alex Oxenstiern, who became one of the first statesmen of Europe. Failing to make peace with Denmark, Gustavus took the field in person, and nearly lost his life in the battle of Widsji; but in 1613 he succeeded through the mediation of England in making peace. The Russian throne was then vacant. The Swedes and Poles each set up candidates for it, Charles Philip, brother of Gustavus and Ladislaw, son of Sigismund. Both had invaded the country and made extensive conquests and Gustavus granted favorable terms to Denmark that he might turn his attention to this quarter. Michael Romanoff, elected in 1613, was compelled to make peace with Sweden by the cession of all his Baltic provinces; and Sweden, which notwithstanding internal troubles had been advancing in political importance since the time of Gustavus I, now became the leading power of the North. The war of succession with Poland still continued and in 1621 Gustavus turned his arms against that country and captured Riga. The war continued for nine years, and was concluded by the six years' truce of Altmark in 1629. Gustavus retained four frontier towns of East Prussia.

Sweden was now about to take for the first time a leading part in the affairs of Europe. Gustavus had been watching with anxiety the course of events in Germany, and had determined to interfere on behalf of the interests of religion and the political rights of the Protestant princes. (For the events of this war and the effects of the intervention of Sweden in the affairs of Europe see GUSTAVUS; PRUSSIA; RICHELIEU; THIRTY YEARS' WAR, and other articles). The body of Gustavus, who fell at the battle of Lützen, was brought back to Sweden in 1632, and his daughter Christina was recognized as his successor. She was a minor, and the management of affairs devolved upon the Chancellor Oxenstiern. He confirmed his alliance with the German rulers, and made arrangements to prosecute the war with vigor. His power continued absolute till 1644, during which time the war in Germany continued. At the beginning of this year a war broke out with Denmark, provoked by the scheming of the queen-mother, who was jealous of the power of Oxenstiern. Denmark was suddenly invaded by Torstenson. Christina assumed the reins of government on 5 Dec. 1644, her 18th birthday. The peace party now prevailed, and the treaty of Brömsebro was concluded with Denmark, which ceded to Sweden the greater part of her possessions in Götland, and exempted Swedish vessels from Sound and Belt dues. The peace of Westphalia, 24 Oct. 1648, gave Sweden western Pomerania, the duchy of Bremen and other acquisitions in Germany, with a seat and triple vote in the diet.

The reign of Christina began under favorable auspices. She had received a masculine education, and showed great attention to business and determination in supporting her views. Contrary to the advice of Oxenstiern she exerted herself to promote peace both with Denmark and Germany. She patronized learning, and drew many distinguished men to her court; but she was extravagant in her expenditure, licentious in her behavior, and soon brought herself into inextricable difficulties by the profusion with which she lavished the crown domains on worthless favorites. In these circumstances she renounced the crown in 1654 in favor of her cousin Charles Gustavus, son of the count palatine, professed the Catholic religion, and after an extraordinary career died at Rome in 1689. The short reign of Charles X was distinguished by some brilliant military enterprises, which extended to Poland, Prussia, Russia and Denmark. In January 1658 he crossed the sea on the ice, and occupying the island of Fünen without resistance, advanced to Copenhagen. By the mediation of England and France peace was concluded at Roeskilde, 8 March 1658, Denmark surrendering the remainder of her possessions in Götland. Charles, however, had set his heart on the conquest of Denmark, and was not long in recommencing operations against that country. He died suddenly on 13 Feb. 1660, leaving a son, Charles XI, only four years of age. A council of regency was appointed, which soon concluded peace with Poland, the emperor and the elector of Brandenburg. Peace with Russia was not concluded till 1661. Sweden formed an alliance with England against Holland in 1665, and took part in the triple alliance against France in 1668. The common policy of Sweden was to ally herself with France, and her change of policy was due to the failure of French subsidies. By the treaty of Stockholm, 14 April 1672, she agreed to assist France if attacked by any German power during her war with Holland. In consequence of this treaty the Swedes invaded Brandenburg in 1674. They were defeated by the elector at Fehrlallin, 28 June 1675. After this victory Denmark entered into a league with the elector against Sweden. In the hotly contested war which ensued Sweden was defeated by the elector on land and by the Danes at sea, but her ally was victorious, and Louis XIV compelled the elector by the treaty of Saint Germain-en-Laye to restore to Sweden all her German possessions except a district beyond the Oder, and by the treaty of Fontainebleau Christian V engaged to restore all his conquests to Sweden. Peace was concluded on these terms between Sweden and Denmark at London, 26 Sept. 1679.

Sweden, whose financial resources were always limited, had, however, been impoverished by the war, and the nobility, who during the minority of Charles had acquired the chief power in the state, although the king had assumed the government in 1672, became unpopular. A revolution was accomplished in 1680, in which the states, under the guardianship of a military force, declared Charles absolute and irresponsible, and entitled to dispose of the government by his last will. The remaining years of Charles XI were employed in organizing the army and restoring the finances. He adopted a regular system of conscription, which greatly strengthened the military power of the nation. He died 15 April 1697. His son, Charles XII, born in 1682, was declared of age in November. His youth induced Denmark, Poland and Russia to enter into a league against him to partition his dominions. Embarking for Copenhagen in 1700, he soon disconcerted the plans of the allies, and refusing peace began a career of conquest, which after many marvelous successes ended in the disastrous battle of Poltava, 8 July 1709. After an exile in Turkey he returned to Sweden in 1714, reconciled himself with Peter the Great, and was pushing the conquest of Norway when he was killed at the siege of Frederickshall, 30 Nov. 1718. The Swedish states passing over Charles Frederick, son of Charles' elder sister, named the second sister of Charles, Ulrica Eleonora, queen, who in 1720 associated with her husband Frederick I. The revolution was accomplished so suddenly that it led to a suspicion that Charles' death had been anticipated, and it has always been suspected that he fell by the hand of an assassin. The new government allied itself with Great Britain, and ceded the duchies of Bremen and Verden, the cause of quarrel between Charles and England, to George I. Peace was concluded with Poland on the basis of the treaty of Oliva, and with Prussia, to which Sweden ceded the territory between the Oder and the Peene, Stettin, the islands of Wollin and Usedom, etc. By the Treaty of Stockholm, 12 June 1720, Sweden paid Denmark 600,000 rix-dollars, and renounced the freedom of the Sound, while Denmark restored Rügen and other conquests in Pomerania and elsewhere. War still continued between Sweden and Russia. It was concluded by the Treaty of Nystadt, 10 Sept. 1721. Sweden received $2,000,000 for Livonia, but she finally lost the valuable Baltic provinces for which she had so long contended. Of her conquests Russia only restored Finland.

Sweden was now under the hands of an oligarchy. This council was easily bribed by foreign powers. It was divided into two factions, called (after 1738) the Hats and Caps, the former of which preferred to sell themselves to France, the latter to Russia. On the breaking out of the war of the Austrian Succession, the Swedes, who had been irritated by the murder, at the instigation of the Russian Empress Anna, of their Ambassador to the Porte, were easily induced by France to declare war with Russia. The war on the part of Sweden, from military incapacity and the selfishness of her civil rulers, was ill conducted. On the accession of Elizabeth peace was concluded by the Treaty of Abo, 17–18 Aug. 1743, by which Sweden renounced forever her claim to the provinces ceded by the Treaty of Nystadt, the recovery of which was the main object of the war, and ceded part of Finland, the boundary between the two states being fixed at the river Kymené. By the influence of Russia Adolphus Frederick of Holstein was elected successor to the Swedish crown, to which he succeeded on the death of Frederick in 1751. During this reign Sweden took some part in the Seven Years' War. At home the country was distracted by the rivalries of the Hats and Caps, and the royal power sank to a shadow. Adolphus died in 1771 and was succeeded by his son Gustavus III. His reign was distinguished by a monarchical revolution. He undertook a war against Russia, which brought him fame indeed, but was productive of no other result. Gustavus was assassinated in 1792. In 1809 his son Gustavus IV was deposed, and his family declared forever incapable of succeeding to the crown. (The leading events of his reign will be found under GUSTAVUS IV). His uncle, the Duke of Sudermania, was declared king with the title of Charles XIII. He concluded a war with Russia, begun by Gustavus, by the Treaty of Fredericksham, 17 Sept. 1809, by which Sweden surrendered Finland, the Aland Isles and part of West Bothnia to Russia. In 1810 the states elected Jean Baptiste Bernadotte, crown-prince. In the final struggle with Napoleon previous to 1814 Sweden joined the Allies, while Denmark took the part of France. The Danes were driven out of Holstein by Bernadotte, and the Treaty of Kiel was concluded between Sweden, Denmark and Great Britain, 14 Jan. 1814. Sweden by this treaty ceded to Denmark her last German possessions in Pomerania, and the Isle of Rügen, while Denmark was compelled to cede Norway to Sweden as a compensation for the loss of Finland. The cession was confirmed by the Norwegian Storthing on 4 November. Greenland, the Faroe Islands and Iceland, which had belonged to Norway, were retained by Denmark. Sweden now held the whole Scandinavian Peninsula, and had lost all her other European possessions. Bernadotte succeeded to the crown in 1818, under the title of Charles XIV. Under his reign Sweden advanced greatly in agricultural and mercantile prosperity. He died in 1844, and was succeeded by his son Oscar I, who introduced extensive reforms in the government. (See OSCAR I). He died 8 July 1859, and was succeeded by his son, Charles Louis Eugene, under the title of

Charles XV. Charles XV died 18 Sept. 1872, and was succeeded by his brother, Oscar II, who, dying on 8 Dec. 1907, was succeeded by his son, the present king Gustav V. On 7 June 1905, owing to the refusal of Sweden to grant separate consulates to Norway, the Storthing of Norway passed a resolution to dissolve the union, which was finally ratified by the Treaty of Karlstad by both countries on 16 October. On 20 November Prince Charles of Denmark was made King of Norway.

In 1909 Sweden experienced one of the most extensive industrial strikes in the history of labor disputes. Beginning in a few industries, this strike soon involved nearly 300,000 men and lasted for two months, completely paralyzing all trade, commerce and transportation facilities and ending in the defeat of the strikers.

Sweden in the World War.— The World War, while it stimulated agricultural production and certain branches of mining, entailed great hardships on the majority of the people, and «hunger» demonstrations became frequent, especially in the urban districts. Up to the later stages of the war the attitude of the Court (the Queen was formerly Princess Victoria of Baden), the military and official classes generally, was one of «benevolent neutrality» toward the Central Powers, while that of the Socialists, although neutral, was more favorable to the Entente. The strict enforcement of the British blockade by the seizure of «contraband» designed to be sent through Sweden to Germany, and the detention of mails from the United States, caused intense irritation; and on the other hand, the German submarine campaigns, and the sinking of Swedish ships, raised considerable feeling against Germany. Sweden's position as a neutral was seriously compromised by the revelations made by the United States government in September 1917 that the Swedish Foreign Office was permitting German official messages from foreign countries to be sent as its own messages, these including messages from Count Luxburg, German Chargé d'Affaires at Buenos Aires, in reference to the sinking of ships of the Argentine Republic by submarines, the most extraordinary of which advised his government that Argentine vessels should not be sunk at all, or «sunk without leaving any trace» (spurlos versendt). These revelations raised a storm of indignant protest in all Allied countries, and a breach of diplomatic relations between Germany and the Argentine was narrowly avoided. Two changes of government were made in Sweden in 1917, the return of the second of which, under the premiership of Mr. Eden, ensured a national policy more acceptable to the Entente nations. The attempt to hold an International Peace Conference, promoted by Socialist groups in warring and neutral countries, was prevented by the refusal of the French, British and Italian governments to issue passports.

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SWEDENBORG. See SWEDBERG.

SWEDENBORGIANS. See CHURCH OF THE NEW JERUSALEM.

SWEDISH LANGUAGE.— The North Germanic dialects seem to have differed very little from each other originally. A fairly uniform language was spoken all over the North which in English and Scandinavian sources is often referred to as «Donsk tunga.» During the Viking age, between 700 and 1100, four dialects developed from the original Old Norse: Icelandic, Norwegian, Danish and Swedish. The former two are grouped together as Westnorse, the latter two as Eastnorse. Among the distinguishing features may be mentioned the passive ending -s for Eastnorse, where Norwegian and Icelandic have -sk, f. i. kallas «to be called» versus kallask. The Old Swedish period extends to the time of the Reformation and covers geographically not only Sweden proper, but also the coast districts of Finland and Livonia. Our knowledge of the earlier stage of Old Swedish is based on Runic inscriptions which only in the 13th century were replaced by the Latin alphabet. During the later Middle Ages many phonetic changes took place which tended to differentiate Swedish more and more from the other Scandinavian branches, such as lengthening of vowels, the Genetive ending -s instead of -r, the relative pronoun sum in place of aer, etc. The vocabulary absorbed many foreign elements, especially from Danish and German, as f. i. numerous industrial and commercial terms, all the verbs in -era (= German -ieren), the suffix -het (= heit), the prefixes be-, bi-, unt-. From this somewhat chaotic stage of transition which is characterized by absolute lack of linguistic norms or standards, modern Swedish emerges gradually as a literary language. The first complete Bible translation which is named after Gustavus I and appeared in 1541 is regarded as the first monument of modern Swedish literature. Throughout the 17th century grammarians and purists made efforts to create national standards and to eliminate foreign elements. In spite of that, however, a large number of French words crept into Swedish, especially in the 18th century and have maintained themselves to this day. The internal linguistic changes concern chiefly the simplification of case endings or inflections and the adoption of certain sound-shifts which are characteristic of modern Swedish, such as the sh-sound for combinations like sj, stj, sk, skj. The pronoun of address became ni instead of I. Since the middle of the 18th century Swedish grammar has changed very little, while the vocabulary shows quite a different appearance, particularly since the enormous wealth and variety of expression which is stored up in the dialects has been utilized by modern writers. The dialects of Dalarna and the island Gottland are especially noteworthy on account of their quaintness and archaic character.

Accent.— Longfellow who first introduced

Swedish writers to the American public, characterizes the Swedish language as soft and musical with an accent like the Lowland Scotch. Jacob Grimm considered it even the most musical of all Germanic languages, comparable to Italian among the Romance languages. This musical character of Swedish is partly explained from the fact that it has retained full endings like -a and -o in many positions where the other Germanic languages have substituted -e or dropped them entirely. More important, however, are the peculiar laws of pitch and modulation which hardly any other language has developed with such consistency. Certain combinations of stress and tone result in definite forms of a musical cadence of «tonlag.» The simple tonlag, or acute accent, differs very little from that employed in other languages, the compound tonlag occurs only in Norwegian and Swedish: the voice first sinks about two tones and rises suddenly two or three tones on the second syllable with a weak secondary stress. The question of accent and modulation is one of the chief difficulties in the study of Swedish.

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EWALD A. BOUCKE,
German Department, University of Michigan.

SWEDISH LITERATURE. The intellectual life of the North has been at all times more or less dependent on central Europe, especially on German and French civilization. Swedish literature shows these influences in a marked degree and has only within the last generation produced writers of distinct originality and more than national significance. The mediæval period appears rather meagre as compared with those of Norway and Iceland. Codes of laws, chronicles, legends of saints, adaptations of chivalrous romances and didactic writings: these or similar categories cover a literary activity which is altogether imitative and chiefly of philological interest. Among the historical documents may be mentioned the Erics-chronicle, covering the period from 1230–1320, the New Chronicle (1490) and the so-called Small Rhymechronicle which contains some interesting autobiographies of Swedish kings. The most conspicuous religious character of the later Middle Ages was Saint Birgitta who, after an extended experience as wife and mother, turned her mind to things spiritual, undertook reforms of all kinds, founded a religious order, came in touch with the leaders of German mysticism and died 1373 in Rome. She contributed to Swedish literature a volume of visions or «revelations» which in spite of their abstruseness exhibit a remarkable power of imagination. Her personal influence and the activity of the Birgitta order which was centred in Vadstena, can be traced through the whole intellectual life of the North, especially in the direction of building up a national church and encouraging the use of the mother tongue. The ballad literature of the 14th and 15th centuries is not as extensive as that of Denmark or Germany, but corresponds otherwise in subject and form. Many of these lays and ballads wandered evidently from one country to the other and exist in numerous versions. More than 60 have been counted of the famous ballad 'Elveskud' (translated by Herder as 'Erlkings Daughters') which describes the dangerous lure of dancing elves. The Swedish ballads have been collected by Geijer and Afzelius as 'Svenska folkvisor' (new edition by Bergström, 1880).

Swedish thought and literature received a powerful stimulus from the gradual adoption of the Lutheran faith in the course of the 16th century. This movement is closely associated with the names of the brothers Petri, Olavus and Laurentius, and of Laurentius Andreae. All three of them contributed to the translation of the Bible which appeared complete in Upsala in the year 1541 and which for the history of the literary language in Sweden may claim a similar position as Luther's translation for German. Apart from a rich controversial literature called forth by the religious movement, we meet with attempts in the dramatic field, such as treatment of biblical stories, allegories and school comedies. The most versatile writer of this period is Johan Messenius who, among other things, planned a systematic dramatization of subjects taken from Swedish history but who only completed six of such plays.

The heroic century of Modern Sweden, the age of Gustavus Adolphus and Charles XII, proved to be relatively unproductive in the field of literature. The dominant influence of Renaissance poetics throughout the 17th century discouraged spontaneous expression and established in most European countries classicistic standards and a rule of formalism. Sweden reveres her «father of literature» in Georg Stjernhjelm (1598–1672), a stern disciplinarian who aimed at purity of language and formal perfection. He wrote a number of epic and didactic poems of an allegorical character, among them his famous 'Hercules at the Crossroad' and distinguished himself besides as a scholar and scientist in many fields. He introduced a number of classic and romantic metres into Swedish poetry and handled them with remarkable skill. His contemporary Gunnar Dahlstjerna employed even the Ottave rime (with six iambic feet) in his patriotic poem 'Kungaskald,' and is still appreciated as the author of 'Götha Kämpevisa' in which Charles XII and Peter the Tsar are the leading characters. The greatest metrical genius of his age was Johan Runius (d. 1713), while the Finlander Jacob Frese shows more natural poetic talent. Samuel Columbus and Jesper Svedberg contributed some of the most popular Swedish hymns. The anatomist and botanist Olaf Rudbeck (1630–1702) still arouses our smile as the author of the treatise 'Atlantika' in which he tried to prove that Plato's Atlantis was identical with Sweden and that here or nowhere else must have stood the cradle of civilization. Rudbeck taught at Upsala which under the reign of Queen Christine had become a great centre of learning and attracted temporarily scholars from all parts of Europe, even men like Descartes, Hugo Grotius and others.

The literary sceptre of Stjernhjelm as dictator in the republic of letters passed later into the hands of Olof von Dalin (1708–63) who in his literary style and ambitions might be compared with the English rationalist Pope. He began his career by editing a periodical *The Swedish Argus* which was modeled after Addison's *Spectator,* and developed later into an excellent prose writer and brilliant satirist. His 'Saga om Hästen' («tale of the horse») is still enjoyable as a specimen of rationalistic wit and allegory. While Dalin leaned at first on English models, the literary taste of the age continued on the whole to be French, first in the manner of Voltaire as in the case of the «dioscuri» Creutz and Gyllenborg, or of Kellgren and Leopold, later in the manner of Rousseau whose theories were introduced into Sweden by Thomas Thorild. Among the literary productions of this school deserve special mentioning Creutz' 'Atis and Camilla,' a charming idyl in the style of Gessner, Kellgren's 'Nya Skapesen' (the new creation), and Wallenberg's novel 'Min Son på Galejen' (my son on the galley), a great favorite to this day on account of its splendid humor. King Gustavus III (1771–92), nephew of Frederick the Great and one of the most gifted rulers of his age, did not only further the arts and sciences in the most generous way, but wrote several patriotic plays of considerable merit. Among Gustavus' immediate friends who attained temporary fame are Count Ehrensvärd, Count Oxenstjerna, Bengt Lidner, the poet of sentiment and passion, G. Adlerbeth, author of 'Ingjald Illråda,' the most famous Swedish tragedy of this age. The revolutionary pathos of Thomas Thorild inaugurates the new emotionalism in Sweden which worshipped at the shine of Rousseau, Klopstock and Ossian. Before entering upon this new phase a word ought to be said about the most unique lyric poet of this century who is still dear to the hearts of his countrymen: Karl M. Bellman (1740–95). He belongs with Robert Burns, or the French vagabond Villon to the class of literary bohemians who seem to be entirely free from the shackles of school or convention, who appeal to us more like voices of nature or immediate transcripts of the life around them. Bellman's best-known poems, among them those dramatic sketches of tavern life, are contained in the collection: Fredman's epistles. They seem more like free improvisations than finished works of art, but it is this wonderful freshness and bold impressionistic manner which fascinates the modern reader as much as their original audience.

The transition from the older 18th century formalism to the Romantic age in Sweden presents quite a dramatic spectacle. The first writers who showed a more adventurous spirit, were Franzén and Wallin, the latter still known as the editor of the Swedish psalm-book and as the author of a glowing ode addressed to George Washington. After the revolution of 1809 the Swedish Academy ceased to be arbiter of public taste, and soon the leading writers of the Romantic movement in Germany were eagerly studied and imitated. Two parties formed and carried on a lively feud for a number of years: the Phosphorists, so called after their periodical 'Phosphorus,' were more interested in the speculative elements of German mysticism, as represented by Schelling or Novalis, the Gothicists wished to strengthen national ideals and to revive the old sagas and ballads of the romantic Middle Ages. The head of the first group was Peter Atterbom (died in 1855), whose phosphorescent visions recall somewhat the ethereal, transcendent style of Shelley or Keats. Other members were Nyberg, Dahlgren and Stagnelius, a mystic and seer, reminding of Blake. The leading minds of the Gothicists were Erik Geijer, equally great as poet and historian, Per Ling who tried to revive the old saga style, and his much greater follower Esaias Tegnér, author of the Frithjofs Saga, Sweden's national epic. Somewhat independent of either school remained Karl Nicander who selected chiefly Italian subjects and themes for his poetry, Chr. Fahlcrantz, still quoted as a humorist, and Johan L. Almquist (1793–1866), an erratic genius who combined exquisite delicacy of sentiment (as in his collection of lyrics: Törnrosens bok) with an extravagant, even lawless imagination and quite heterodox views on love and marriage.

The chief by-product of the Romantic movement, the historical novel, flourished in Sweden perhaps even better than in England or Germany. Gumälius, Crusenstolpe, Ridderstad, Sparre and many others have contributed to this genre. The Finlander Topelius' so called 'Surgeon's Stories' which cover nearly two centuries of Swedish history, were widely read in this country at one time, but slumber now peacefully on the shelves of our libraries side by side with Rydberg's famous novel 'The Last Athenian,' and with Frederika Bremer's once so popular stories and sketches of Swedish home life. The last-named writer appears already quite emancipated from Romantic doctrines and points toward the coming age of Realism. Swedish literature, as may have been noticed, is immensely rich in the field of lyric poetry, whereas the realistic novel of the Dickens or Eliot type is rather poorly represented. Fr. Cederborgh, Karl Wetterberg, August Blanche, Sofie von Knorring and a few others present various aspects of Swedish life and society in their novels. The realistic note which had already been heard in the poems of Anna Lenngren (died 1817), becomes more and more prominent, and is reinforced by humor and satire in the songs of W. von Braun, Wennerberg, Sturzenbecker, and the witty improvisations of Johan Wadman. But all these minor talents disappear by the side of the greatest poetic realist of his age: Johan L. Runeberg, the pride of Finland. His chief work is a collection of patriotic poems and ballads: 'Ensign Ståls Tales,' which were inspired by the second Finnish War in 1809, and are rightly considered the most beautiful tribute that has ever been paid, to the patriotic enthusiasm of a small nation. The idyls 'Elkhunters' and 'Hanna' show the influence of Goethe's epic style and, with a large number of exquisite lyrics, give evidence of Runeberg's remarkable power to invest the simplest and most primitive aspects of life with genuine pathos and poetic dignity. He deserves to be classed in this respect with poets of the rank of Goethe or Wordsworth. Runeberg taught for many years in Borga, Finland, and died in 1877.

Two years after Runeberg's death, in 1879, there appeared a novel in Sweden under the title 'The Red Room' by August Strindberg, which inaugurated a new type of Realism and a new literary era. A few years later Geijerstam attempted in his first novel 'Erik Grane' to epitomize the great intellectual and social revolution which had gradually spread from one country to the other and was inspired by three constructive ideals: a political and social democracy, a reconciliation of science and religion, and a new æsthetic creed which subordinated beauty to truth. The commanding figure in this movement is August Strindberg, epochmaking in all fields of literature and at all times a seeker of truth. Most of his writings are now accessible in English translations. Gustav af Geijerstam (1858-1909) who as a novelist has gained great popularity both in Sweden and Germany, is practically unknown to the American reader. This may be explained from the distinctly national or even provincial character of his art, partly from the peculiar inwardness and subtlety of his analysis which avoids striking plots or situations and instead delves down into the deeper strata and hidden recesses of soul life. However, such stories as 'Astray in Life,' 'Pastor Hallin,' or some of his short stories deserve to be translated and might appeal more than some of Strindberg's rather morbid productions. Among the younger followers of the new realism may be mentioned Albert Engström, editor of the periodical 'Strix' and known through his descriptions of peasant life, sailors and fishermen. Two Swedish American novels may be added, one by Hilma Angered-Strandberg, called 'The New World' describing the struggle and failure of two people who have come to this country, the other by Henning Berger, 'Isail' which contains a splendid description of Chicago as the great melting pot of races. The influence of Maupassant and Flaubert is noticeable in Hjalmar Söderberg's clever sketches of Stockholm society ('Historietten' and 'Blunders'), as well as in his novel 'Martin Birk's Youth,' a story of disillusioned youth. Sigerid Siwertz, a short story writer, seems to develop in a similar direction, as f. i., in his collection 'The New Robinson.'

Since 1890 the pendulum seems to have swung back in the opposite direction of an idealistic or neoromantic interpretation of life. Such is the literary creed of Selma Lagerlöf, the leading writer of the day, whose wondrous tales from Gösta Berling to the 'Emperor of Portugallia' are being read in many languages. Her art certainly bears out Walter Pater's definition of the romantic as 'strangeness added to beauty.' Far less known is Verner von Heidenstam, author of the 'Karolinerna,' a series of tales grouped around the heroic figure of Charles XII. This book has already become a classic. Oscar Levertin (died in 1906) may be regarded as the leading critic and essayist of this school. His earlier lyrics, like those of Heidenstam's, reveal a dreamy brooding mysticism and great delicacy of feeling. Even more elusive are Ola Hansson's interpretations of nature and soul-life in his 'Sensitiva amorosa' and 'Young Ofeg's Ditties' (transl. by G. Egerton). Per Hallström has attracted attention as a stylist of pronounced individuality and a lover of southern beauty in a number of delicately chiseled stories and sketches. His prose writings correspond somewhat to the lyrical poetry of Count Snoilsky (died 1903), which is distinguished by great formal beauty and its rich cultural suggestiveness. Quite an opposite type, though equally great in his way, is Gustaf Fröding (died 1911), who renewed the impressionism of Bellman and his model Robert Burns but covers a wider range of experience. He is an enthusiastic worshipper of life tempered by an element of irony and even cynicism. ('Guitar and Accordion' 1891). The youngest generation is represented by the Finlander Gripenberg, the naturalists Bååth and Bo Bergman, and Sigmund Agrell, a follower of Hallström. Present day novelists are Sven Lidman (the life of Swedish nobility), Gustaf Janson (cosmopolitan and visionary), Mathilde Roos (conservative). A group of writers make Norrland, the country of sawmills, the background of their novels, like Erik Forsslund in 'Storgården,' Martin Koch, Olaf Högberg, L. Nordström. The drama, at all times strangely unproductive in Sweden, has little to show, since the days of Strindberg, but temporary successes like Hallström's charming 'Venetian Comedy,' Harold Morlander's 'Rococo' and Söderberg's 'Gertrud' (1906). The most promising dramatist of the day is Ernst Didring.

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EWALD A. BOUCKE,
German Department, University of Michigan.

SWEDISH MOVEMENT-CURE, a system of therapeutics devised by Pehr Henrik Ling (1776–1839), a Swedish poet, and fostered and developed by the Swedish government. It consists of remedial or localized movements of muscles to restore the normal movement of the contents of cells when it has become disarranged. This method, as variously modified by the development of modern mechanotherapy, is often associated with massage. The muscular movements (active or passive) are effected either by various machines or by the hands of the operator, which flex, extend, twist, tap, knead, rub and roll the various muscles. The Swedish movement-cure, or, to speak more broadly, the movement-cure in general, embraces scientific and valuable modes of treatment. But their application requires good judgment. If properly used, mechanotherapy as thereby employed improves the nutrition of the whole body, relieves congested and engorged organs and tends to restore animal heat to its normal point. Improperly used, such methods may do much harm. See MECHANOTHERAPY; THERAPEUTICS.

SWEENY, Thomas William, Irish-American military officer: b. Cork, Ireland, 25 Dec. 1820; d. Astoria, L. I., 10 April 1892. He came to the United States in 1832 and settled in New York where, after finishing his education, he was apprenticed to the printing business. He early identified himself with the military companies of the city and at the breaking out of the Mexican War in 1846 became second lieutenant in the First New York Volunteers, commanded by Col. Ward B. Burnett. Lieutenant Sweeny participated in all the battles of the campaign under Gen. Winfield Scott from the siege of Vera Cruz to the storming of Churubusco, where he was twice severely wounded, losing his right arm 20 Aug. 1847. On his return to New York, in 1848, he was given a reception ball at Castle Garden and was presented a medal by the Corporation of New York. He was engaged in almost constant operations against the Yuma and other Indian tribes until the fall of 1853, when he was sent to New York on recruiting duty. In 1854 he was ordered to Fort Pierre, Nebraska Territory, where he took part in the Sioux campaign of 1855–56 as aide to Gen. William S. Harney. On 19 Jan. 1861 he was promoted captain, second infantry, and soon after was sent to Saint Louis, Mo., by order of General Scott, and placed in command of the arsenal, which he saved by threatening to explode the 40 tons of powder stored there in case the Secessionists attacked him. He was at the capture of Camp Jackson, where he was second in command of the Union forces and, owing to the disability of General Lyon, carried on the negotiations which brought about the surrender. He became brigadier-general of Missouri Volunteers in May 1861. Previous to the battle of Wilson's Creek, when General Lyon had expressed his intention to retreat, he prevailed upon Lyon to remain and give the enemy battle. In the subsequent battle he led the Second Kansas Regiment, and was severely wounded in the right leg. He accepted the colonelcy of the 52d Illinois Volunteer Infantry in January 1862 and after the capture of Fort Donelson had charge of 5,000 prisoners of war. Toward the close of the first day of the battle of Shiloh, where he commanded a brigade, his command occupied a ravine, the defense of which was entrusted to him by General Sherman, who afterward said: «He held it, and I attach more importance to that event than to any of the hundred achievements which I have since heard 'saved the day.'» General Sweeny was commissioned brigadier-general of volunteers 29 Nov. 1862 and was engaged in protecting the Memphis and Charleston Railroad. He was promoted major 16th United States Infantry 20 Oct. 1863 and was present at the fighting at Iuka and the siege of Corinth. In the Atlanta campaign he commanded the second division, 16th Corps, Army of the Tennessee. He participated in the battle of Resaca and at Lay's Ferry forced a passage across the Oostenaula River and fought a battle that compelled Gen. Joseph E. Johnston to retreat with his army. He took part in the battles of Dallas and Kenesaw Mountain, the actions at Nickajack Creek, Ruff's Mills, Rome Cross Roads, Calhoun's Ferry and other engagements, and at the battle of Atlanta 22 July 1864 he repulsed the enemy with great slaughter, capturing four battle-flags and 900 prisoners. In 1866 he was engaged in the Fenian invasion of Canada. During this period he was out of the national service, but he was reinstated by the President and ordered to the Department of the South, where he was in command of the post of Augusta, Ga., and, subsequently, that of Atlanta, Ga. General Sweeny was presented a sword by the city of Brooklyn in August 1862 for his services in the Civil War. He was finally retired from active service 11 May 1870 with the full rank of brigadier-general, United States Army. Consult 'Battles and Leaders of the Civil War.'

SWEENY, William Montgomery, son of the foregoing: b. New York, 29 Aug. 1871. He was educated at public and private schools and academies in New York and Augusta, Ga. He has written for the press and contributed biographical articles to 'Officers of the Army (Regular) who served in the Civil War' (Philadelphia 1892); 'History of the Twelfth Regiment, N. G. N. Y.' (New York 1894); 'Journal of the American-Irish Historical Society' (Boston 1899); White's 'National Cyclopædia of American Biography' (New York 1901) and Lamb's 'Biographical Directory of the United States' (Boston). He is the author of the 'Life and Services of Thomas William Sweeny, Brigadier-General, United States Army' (New York 1907) and editor of 'Sweeny's Narrative of Army Service' (1846–53); 'Captain Thomas Cook, a Soldier of the Revolution (1752–1841)' (New York 1909) and 'Some Notices, Genealogical and Historical, of the Cook, Dandridge, Higginbotham, Morrison, Reagan, Refo and Sweeny Families' (in manuscript).

SWEET, Benjamin Jeffrey, American military officer: b. Kirkland, N. Y. 24 April

1832; d. Washington, D. C., 1 Jan. 1874. In the Civil War he was colonel of the 21st Wisconsin regiment. In 1864 he was placed in command of Camp Douglas, Chicago, where 10,000 Confederates were imprisoned and successfully circumvented the efforts of Confederate societies to seize Chicago and liberate their friends. He was made brigadier-general of volunteers in 1865 and in 1872 was appointed first deputy commissioner of internal revenue.

SWEET, Henry, English philologist: b. London, 1845; d. 30 April 1912. He was educated at King's College, London, at Heidelberg University and at Balliol College, Oxford. He devoted himself to the study of phonetics and Old English philology and became one of the foremost authorities on both subjects. His researches into Chinese and Arabic were also of high value. From 1901 until his death he was University reader in phonetics at Oxford University. He edited numerous Old and Middle English works and was author of many papers on philology and of 'A History of English Sounds' (2d ed., 1888); 'Primer of Phonetics' (1890; 3d ed., 1906); 'The History of Language' (1900), etc.

SWEET, John Edson, American engineer: b. Pompey, N. Y., 21 Oct. 1832; d. 8 May 1916. He was educated in the district schools, became a carpenter's apprentice and rose to be a builder and architect in 1850. He was employed in his profession in the South until 1861; engaged as an inventor and mechanical draftsman until 1873; from 1873–79 was professor of practical mechanics at Cornell. From 1880 he was president of the Straight Line Engine Company. He founded the American Society of Mechanical Engineers, of which he was president in 1883–84, and an honorary member. On his 80th birthday in 1912, he was given a banquet by the society. He was government expert and juror on machine tools at the World's Columbian Exposition in 1893 and in 1899–1901 was first president of the Engine Builder's Association of the United States. In 1904 he was given the John Fritz Medal, which is awarded by a board of 16 of the leading members of the Mining, Civil, Mechanical and Electric Engineering Societies. In 1914 Syracuse University conferred upon him the degree of Doctor of Engineering.

SWEET-BAY, the classic laurel (*Laurus nobilis*), or bay-tree of the Mediterranean regions, which becomes a tree of some 50 feet in its native habitat, but is cultivated as a shrub farther north, being often trimmed like box. (See BAY). It has handsome, lanceolate evergreen leaves, dark-green and shining, which have an aromatic odor and taste and are, therefore, employed in cookery and for packing figs. They have also some therapeutic value and yield a thick oil which is incorporated into ointments and liniments. The sweet-bay of America is the small tree (*Magnolia virginiana*) called more frequently swamp-magnolia or swamp-laurel. See MAGNOLIA.

SWEET-BRIER. See EGLANTINE.

SWEET-FERN, a low shrub (*Comptonia peregrina*), with many brown branches and long linear leaves so deeply pinnatifid on either side of the midrib as to appear fern-like. The flowers are diœcious, without perianths, and appear when the leaves expand; the fertile are in globose aments followed by burr-like fruits — bony nuts invested with awl-shaped persistent bracts. The staminate aments are longer and clustered at the ends of branches. The young foliage is pubescent, and the whole plant has a strong aromatic fragrance when bruised or under hot sunshine. It was formerly included in the genus with the spicy-bay-berry and is often found growing with it on sterile soils or on hillsides further inland. The dried leaves are sometimes used as a substitute for tobacco.

SWEET-FLAG. See FLAG, SWEET.

SWEET GALE. See CANDLEBERRY.

SWEET-GRASS, a name given to certain plants, most of which are fragrant, especially in drying. The small *Anthoxanthum odoratum* is the sweet vernal grass and has narrow spike-like panicles of spreading one-flowered spikelets. The leaves are flat. This plant has been introduced from Europe and is found in fields and meadows over nearly the whole of America, adding to the fragrance of newly mown hay. *Savastana odorata* is the vanilla-grass or holy-grass of Europe, which is strewn before the churches and religious processions. It is the material from which the Indians of the Saint Lawrence region weave their thin-walled baskets that, when made of the genuine grass, retain their odor of new mown hay indefinitely. *Panicularia* is a genus of grasses called sweet grass because cattle are said to be fond of *P. fluitans*. Another sweet-grass (*Asperula odorata*) does not in the least resemble grass, having whorls of leaves and white flowers like tiny stars in cymes. When dried it is fragrant, however.

SWEET-GUM, a large American tree (*Liquidambar styraciflua*), reaching its greatest size in the South Atlantic States, where it develops tall, straight trunks, branchless for 70 or 80 feet above the ground. The head is narrowly pyramidal when young, but when old and field-grown the heads are likely to become irregular and rugged. The five-lobed, star-shaped leaves form thick, dark and glossy foliage turning to brilliant hues in autumn, the young saplings especially being gorgeous in large reddish purple leaves, bright-green beneath. The monœcious flowers are inconspicuous and without perianth. They are gathered into erect heads, the pistillate ones being succeeded by odd fruits, globose and spiked with the points of two-beaked woody capsules, which are brown and twisted and allow the scanty fertile seeds to escape through gaping orifices. They hang by long stalks far into the winter. The bark is very rough, and in young branches and saplings is peculiarly winged by numerous gray corky ridges of undulating outline, which have suggested the name of alligator-wood. The wood is smooth and satiny and would be valuable as a substitute for black walnut, were it not so liable to warp and difficult to season. It is filled with a resinous sap, which is used medicinally, and like that of *Liquidambar orientale*, of Asia, might be a source of gum storax. This fragrant sap has prompted the Latin-Arabic descriptive generic name. The sweet-gum is otherwise known as star-leafed gum, liquidambar, bilsted, red-gum or copalm.

SWEET MARJORAM. See MARJORAM.

SWEET PEA, an annual herb (*Lathyrus odoratus*) of the family *Fabaceæ*. It is supposedly a native of Ceylon, Sicily and Sardinia, the original pink-and-white and the red varieties being credited to the first country and the pure white and purple varieties to the other two islands. The known history of the plant begins in 1650, and the first record of its cultivation in 1699, when Father Franciscus Cupani grew it at Panormus, Sicily. By 1730 the seed was commercially known, and about 60 years later five varieties were offered by a London seedsman. Until Henry Eckford commenced experimenting in 1876 for the production of new varieties there were, however, rarely 12 varieties offered in any one year. Largely due to his efforts the list of varieties had risen to 150 in 1898, and the popularity of the flower had vastly extended. It has been estimated that since 1900 the average annual crop of sweet-pea seed is about 100,000 pounds, about one-fifth of which is produced by one company in California, where nearly all the seed used in Europe and America is now grown.

The sweet pea is a hardy annual herbaceous vine with rough, winged stems, tendril-bearing leaves composed of two leaflets borne on long stalks, and fragrant papilionaceous flowers of various shades, ranging from white to blue and red through many tints, and including both double and «hooded» forms. The pods are about two inches long, and contain about six brown seeds. The double varieties are not regarded with favor, being rather unkempt and lacking the daintiness of the single sorts.

For best results in the garden, sweet peas should be planted very early in the spring or even during the previous late autumn. They will thus obtain an early start, and their roots will penetrate more deeply into the cool, moist soil before warm weather arrives, than if sown later. Moderately rich soil of a rather heavy nature generally gives best results; very rich soil tends to grow vine and leaf at the expense of flower; very poor ground is prone to produce small short-lived vines and little flowers which, however, are often pronouncedly fragrant. The seeds should be scattered thinly in trenches about five inches deep and four or more inches broad. The distance between rows should be about three and one-half feet, the seed covered about one inch deep, and as the plants grow the earth should be drawn toward the vines until it forms a ridge two or three inches high. When the plants are well above the surface they should be provided with supports upon which to climb. Brush and poultry netting are generally employed. Throughout the season clean, shallow cultivation should be given and the flowers gathered daily. This last will considerably extend the season since the formation of seed tends to a cessation of growth.

Several closely related species are cultivated for ornamental purposes but are less popular than the above. The best known are probably the following: The Tangier scarlet pea (*Lathyrus tingitanus*), an annual herb which blossoms earlier than the sweet pea and should be planted separately because of its greater strength and its tendency to crowd out the former. The perennial or everlasting pea (*L. latifolius*), an odorless species with many-flowered clusters of diversely colored blossoms. It is popular for planting among rocks, in rough places and for screens, for which its rampant growth and hardiness recommend it. *L. rotundifolius* and *L. grandiflorus* are also called everlasting and are cultivated to some extent, as are also *L. maritimus*, the sea or seaside pea, and *L. palustris*, the marsh or wing-stemmed pea — the latter grown in damp places.

Consult Hutchins, 'All About Sweet Peas' (1894), and 'Sweet Peas Up to Date' (Philadelphia 1897); Bulletins 111 and 127, Cornell Agricultural Experiment Station (Ithaca 1895, 1896); Bailey, 'Standard Cyclopedia of Horticulture' (New York 1916).

SWEET PEPPERBUSH. See CLETHRA.

SWEET POTATO, a tuberous-rooted perennial herbaceous vine (*Ipomæ a batatas*) of the family *Convolvulaceæ*. The plant is of unknown origin but is supposed to be a native of tropical America. It has roundish or angular heart-shaped leaves, and in cultivation rarely produces blossoms or seeds. The flowers resemble those of morning-glory, but are smaller. The tubers, which are borne below the crown of the plant, are without well-defined eyes. The plant was cultivated by the natives before the landing of Columbus. It is now extensively grown in many warm and mild climates, especially in the Southern States, California and the Atlantic Coast as far north as New Jersey. The annual crop aggregates about 50,000,000 bushels, and the yield per acre varies usually between 200 and 400 bushels, though with best management and favorable season 800 bushels or even more are occasionally obtained.

The sweet potato is propagated less by its tubers planted in the field than by sprouts obtained from the tubers in hotbeds, etc. These sprouts or «draws» are transplanted in the field as soon as the weather has become settled and after the land has been deeply and finely prepared by plowing and harrowing. The soil best suited to the crop is a light sandy loam not excessively rich in nitrogenous plant food but not deficient in this respect. Upon heavy soils the tubers are prone to crack because of the uneven growth under varying conditions of moisture and dryness. Plenty of moisture, warm situation and liberal manuring are essential. The ground is kept cleanly cultivated until the vines interfere with tillage. The tubers are dug in the autumn and stored in a great variety of ways, all considered more or less unsatisfactory since the tubers usually decay badly during storage. While the plentiful yield may frequently beg a market in the autumn, the demand from mid-winter onward can rarely be supplied even at advanced figures. These troubles may be considerably reduced by proper care in harvesting. The following practices are recommended: Digging before the tubers start a «second growth,» choosing clear weather when the soil is dry, using padded baskets to reduce chance of scratching the tubers, handling so as to avoid bruising, storing only the perfect specimens and giving perfect ventilation in the storage heaps which should always be located upon knolls or otherwise dry ground. As adjuncts to these practices the beds in which the sprouts are obtained should be made upon clean fresh land with fresh manure and the plants should never be set two years in succession in the same field; three or four years is considered much better. These are all preventive and are thought to be more valuable than special methods of storage in expensive storage quarters.

Consult Georgia Experiment Station Bulletin No. 25 and Farmers' Bulletin No. 26 of United States Department of Agriculture.

SWEET-SOP, the edible fruit of an evergreen shrub (*Annona squamosa*). It is ovate in shape, with a delicious, sweet pulp, enclosed by a thick rind having projecting scales. Although indigenous to America this tree is cultivated for its fruits in all tropical climates, and is also called sweet-apple, or, in India, custard apple — a name which properly belongs to *A. reticulata*.

SWEET SULTAN, a plant. See CENTAUREA.

SWEET WATERS OF ASIA, a river, the ancient Aretas, flowing between Anadoli Hissar and Kandili, on the Asiatic side of the Bosphorus. The Turks call it Ghiok-suyu, "heavenly waters," from the surpassing beauty of its surroundings. The valley is a favorite picnic resort in summer and autumn, when the better class Turkish families may be seen on Fridays (Mohammedan Sabbath) in their private caïques (boats) on the stream or scattered along the shores under luxuriant cypress, sycamore and plane trees.

SWEET WINES. See WINE AND WINE MAKING.

SWELL-FISH. See GLOBEFISH; DIODON.

SWENSSON, Carl Aaron, American Lutheran theologian: b. Sugar Grove, Pa., 25 June 1857; d. Los Angeles, Cal., 16 Feb. 1904. He was graduated from Augustana College, Rock Island, in 1877, and in theology from Augustana Seminary in 1879; was secretary to the General Council of the Lutheran Church of North America in 1885 and its president, 1893–94. He was a member of the Kansas legislature in 1889; founded Bethany College in 1881 and was its president from 1889 till his death. He was the author of hymn books and books of travel in Swedish and English.

SWETE, swēt, **Henry Barclay,** English theologian: b. Bristol, 14 March 1835; d. May 1917. He was educated at King's College, London, and Gonville and Caius College, Cambridge, where he gained several prizes, and was graduated in 1858. He was professor of pastoral theology in King's College, London, from 1882 till 1890, and examining chaplain to the bishop of Saint Albans from 1881 till 1890; and after 1890 was Regius professor of divinity at Cambridge. He was made honorary chaplain to the king in 1911. His published works include 'Early History of the Doctrine of the Holy Spirit' (1873); 'History of the Doctrine of the Procession of the Holy Spirit' (1876); 'Commentary of Theodore of Mopsuestia on the Minor Epistles of Saint Paul' (1880–82); 'The Old Testament in Greek,' according to the Septuagint (1887–94); 'The Akhmim Fragment of the Apocryphal Gospel of Saint Peter' (1893); 'The Apostles' Creed in Relation to Primitive Christianity' (1899); 'Faith in Relation to Creed, Thought and Life' (1895); 'Church Services and Service-books before the Reformation' (1896); 'The Gospel According to Saint Mark, and the Greek Text, with Introduction, Notes and Indices' (1898); 'An Introduction to the Old Testament in Greek' (1900); 'Patriotic Study' (1902), and 'Studies in the Teaching of Our Lord' (1903); 'Works of the Ascended Christ' (1911); 'The Holy Spirit in the Ancient Church' (1912); 'The Last Discourse and Prayer of our Lord' (1913); 'The Holy Catholic Church' (1915). He also contributed articles to Smith and Wace's 'Dictionary of Christian Biography,' (Vols. III and IV, 1882–87), and to Hasting's 'Dictionary of the Bible' (Vols. II and III, 1899–1900).

SWIFT, Gustavus Franklin, American merchant: b. Sandwich, Mass., 24 June 1839; d. Chicago, Ill., 30 March 1903. At the age of 23 he opened a small butcher shop in his native town, but removed to Boston when he was less than 30 years old. He remained in Boston until 1875 when he went to Chicago, where he developed the department of shipping live cattle to eastern markets. In 1877 he evolved plans for the first refrigerator car, and dressed meats, instead of live animals, were shipped to eastern cities. He was the pioneer in this business, and from the small plant started in 1877 developed the great corporation bearing his name.

SWIFT, Jonathan, English clergyman, poet, political writer and satirist: b. Dublin, Ireland, 30 Nov. 1667; d. Dublin, 19 Oct. 1745. Swift was the posthumous son of Jonathan Swift, the neer-do-weel of a prosperous and pretty well-known family which had numbered several preachers in its course since the time of Robert Swifte (16th century) of Yorkshire, the earliest known of Swift's ancestors. The most famous member was Swift's grandfather, Thomas Swift (b. 1595), the famous Royalist vicar of Goodrich. Through Thomas Swift's marriage to Elizabeth Dryden, great-aunt of John Dryden, came Swift's relation to the poet. Swift's mother, Abigail Erick, of Leicestershire was a distant cousin of Sir William Temple and a woman of much character and wit.

Swift's life divides itself conveniently into three periods: to the death of his patron, Temple, in 1699; from that year, when he began to seek ecclesiastical and political preferment, to the close of his brilliant work for the Tory ministry at the death of Queen Anne, in 1714; and from the latter year till his death, during which period he was dean of Saint Patrick's in Dublin, where he almost continuously resided. The story is that he was taken at the age of one year from Dublin to Whitehaven, England, by his nurse, where he lived two years, learning to read in the interval. At the age of six he entered Kilkenny School at the charge of his uncle, Godwin Swift. Entering Trinity College, Dublin, in April 1682, he was graduated four years later without distinction, and the following year was publicly censured for neglect of his studies and for tavern-haunting. At this time he was probably pretty much depressed in spirits and was friendless. His dependence on the charity of his relatives was galling to his pride, and he was unhappy, but his delinquencies were not very serious. Driven from Ireland in the fall of 1688 by the rebellion of Tyrconnel, he and his mother retired to Leicestershire, whence, in 1689, he became secretary to Temple at Moor Park, near London. His position was a somewhat menial one, but his patron's kindness enabled him to take the degree of A.M. at Oxford in 1692. Returning to Temple but finding his position irritating, he refused the latter's offer to obtain for him a clerkship in the Irish Rolls, quarreled with his employer and entered the church. Ordained deacon in October 1694, and priest in January of the following year, he obtained the living at Kilroot, Ireland. Tiring of his position, however, he applied to Temple for reinstatement, and the latter, glad of his help, called him back to a post of greater importance, early in 1696. Here Swift remained till his patron's death in January three years later.

The decade ending with that date is very important to the life of Swift. Intellectually, he was very active and, besides his routine duties, did a prodigious amount of reading. Though he did not always understand his motives accurately, he was nevertheless not far from the truth when he described his temperament in a letter to a friend who had cautioned him to beware of a marriage that his mother feared he was about to make. Protesting that he could have no thought of matrimony until his position in the world was secure, and adding that he was very hard to please, he continued: «How all that suits with my behaviour to the woman in hand you may easily imagine, when you know that there is something in me which must be employed, and when I am alone turns all, for want of practice, into speculation and thought; insomuch, that these seven weeks I have been here, I have writ and burnt, and writ again upon all manner of subjects, more perhaps than any man in England. And this it is which a person of great honour in Ireland (who was pleased to stoop so low as to look into my mind) used to tell me that my mind was like a conjured spirit that would do mischief if I did not give it employment.» (To Rev. John Kendall, 11 Feb. 1691). Whatever may have been the exact truth of the matter, Swift's constitutional restlessness was aggravated by a malformation in the region of the ear, which, resulting in blood pressure, caused the attacks of giddiness and deafness to which he was always subject and which drove him to intense activity for relief (consult Craik, Appendix, XIII, and Collins, p. 237).

His first writings, however, were of no importance. Falling under the influence of Cowley, he produced his first extant poem in May 1689, a very stilted Pindaric Ode to Dr. William Sancroft, and the seven known poems, chiefly odes, which he wrote before 1698 are of no better quality; it was the fourth, 'To the Athenian Society' (1691) that, according to Johnson, caused Dryden's damaging remark, «Cousin Swift, you will never be a poet.» His vein then suddenly changed, and in 'Lines written in a Lady's Ivory Table-Book' (1698) and 'Mrs. Francis Harris's Petition' (1700) he first displayed evidences of the graphic, humorous description and the complete absence of sublimity which distinguish his verse.

Far more striking are the two works which opened his career as a prose writer. Among a probably large amount of writing now lost, he composed, in 1696, 'The Battle of the Books' and 'A Tale of a Tub,' both of which remained unpublished until 1704. The year 1696 may be taken as the date when Swift abandoned his efforts to imitate the writing of other men, and leaped, full-armed, into his own peculiar and inimitable possession, satire. 'The Battle of the Books,' the one piece now read in a once famous controversy, in which Temple had engaged, as to the relative merit of the Ancients and the Moderns, is famous for its satire of affectation, pedantry and obtuseness and for its lively burlesque of the heroic manner. The other book, a much more elaborate affair, by many regarded as Swift's masterpiece, is in its narrative parts a satire against religious abuses and schism, in the persons of Peter, the Church of Rome, Martin, the Anglican Church, and Jack, the Presbyterian sect. This narrative, however, comprises no more than a third of the book; the remainder is taken up with dedications, prefaces and digressions, which variously satirize the vanity, conventionality and affectation of authors, the irreverence and scurrility of the wits of the day, the pedantry, the cheapness and superficiality of contemporary learning, and, in general, fanaticism, unreasonableness, vanity and emptiness. In these two books, written before he was 30, Swift showed himself to be an unrivaled master of irony, burlesque and satire.

In the summer of 1699 Swift became secretary and chaplain to Lord Berkeley, one of the lord justices of Ireland. Disappointed in his efforts to obtain the deanship of Derry, he was made in February 1700 vicar of Laracor, Agher and Rathbeggan, in County Meath, Ireland, livings worth about £200 a year. On the recall of Berkeley in 1701, he went with the latter to London and published his first political pamphlet, 'The Dissensions in Athens and in Rome,' an attempt to show the need of harmony in politics. Though the pamphlet gained the goodwill of the Whigs, Swift's work for the next nine years was wholly in behalf of the Irish clergy. Four journeys to London, of an average duration of over six months apiece, were undertaken chiefly with a view to obtaining remission of the taxes on the Irish livings, and during the same period Swift wrote a number of able pamphlets in support of the established church, of which the masterly piece of irony, 'An Argument to Prove that the Abolishing of Christianity in England may, as things now stand, be attended with some inconvenience, and perhaps not produce those many good effects proposed thereby' (1708), and 'The Sentiments of a Church of England Man, with respect to Religion and Government' (1708), are the most important. During these visits also, Swift came to know the best wits of the time, the chief literary result of which were the famous 'Bickerstaff Pamphlets' (1709–10), a practical satire against false learning in the person of the astrologer Partridge. His principal mission, however, came to nothing; he was put off by the Whig lords, and, personally disappointed because of his failure, owing perhaps to the impression created by 'A Tale of a Tub,' to gain preferment in the Church, he gave his services to the Tory ministry which came into power in 1710.

During the next four years Swift wrote an extraordinary number of political pamphlets; few political writers have ever done a larger amount of brilliant and powerful work. Swift's task was threefold: to show that the cause of the Tory ministry, its desire to obtain a peace with France, was a just cause, and that its members were worthy men; to cast ridicule on the principals and persons of the Whigs; and to restrain the more violent Tories from extreme measures. His first work, after a caustic 'Short Character of Thomas, Earl of Wharton' (1710), was the conduct of the *Examiner*, the Tory weekly, for which he did all the writing between 2 Nov. 1710 and 14 June 1711, contributing a series of varied and able arguments and satires. His position, maintained with singular adroitness, was that the country was crying for a peace and happiness which could be more readily obtained from the Tories than from the Whigs, especially while Marlborough and Wharton were influential. In 'The Conduct of the Allies and of the Late Ministry in Beginning and Carrying on the Present War' (November 1711), commonly regarded as his masterpiece among the writings in support of the Harley administration, his object was to strip the war of its glamor and to render it unpopular by showing that the Allies, with the connivance of the Whigs, had been systematically exploiting England. «After ten years of war with perpetual successes,» he says in his preface, «to tell us that it is impossible to have a good peace is truly surprising — [and] it is natural to inquire into our present condition; how long we shall be able to go on at this rate; what the consequences may be on the present and future ages; and whether a peace, without that impracticable point which some people do so much insist on, be really ruinous in itself, or equally so with the continuance of the war.» Other important tracts were 'The Importance of the Guardian Considered' (1713), a merciless, but not unprovoked attack on Steele, and the savage and fairer answer to Steele's 'Crisis,' the very skilful 'The Publick Spirit of the Whigs.'

Besides his political writing, Swift published many pieces of a miscellaneous kind, including several papers for Steele's *Tatler*, at least one for the *Spectator*, some controversial satires on religious subjects, his historically interesting but philologically unsound 'Proposal for Correcting, Improving, and Ascertaining the English Tongue' (1712), and the well-known 'Journal to Stella.' He had made the acquaintance of Esther Johnson, then a child of eight, during his first residence at Sir William Temple's, and had been the tutor to this ward of his patron. When he got his livings in 1700, she, with her companion, Mrs. Dingley, went to Ireland to live near him, and during his residence in England remained in Ireland. The 'Journal' extends from 2 Sept. 1710 to 6 June 1713, with scarcely a break. The letters, which were dispatched every two or three weeks with an entry for nearly every day, are chiefly the bare narrative, expressed in simple, intimate terms, of what Swift was doing in a social way, and are singularly free from discussion of the politics of the time. They are important as a record of the life and character of a busy and influential man of the time.

As a reward for his great political services, Swift was appointed, on 23 April 1713, dean of Saint Patrick's Cathedral, Dublin, and the following June went to Ireland to take charge of his new office. Returning to London in August of the same year with a view to healing the growing breach between the Tory ministers, Oxford and Bolingbroke, he was unsuccessful and retired to Letcombe, Berkshire. On the fall of Oxford and the triumph of Bolingbroke, he adhered to the fortunes of the former and saw the close of his political career in England. On the death of Queen Anne, 1 Aug. 1714, the downfall of Bolingbroke and the complete triumph of the Whig party, he returned at once to Dublin, where he remained continuously for the next 12 years.

In Ireland he found himself very unpopular, and in his Church had trouble with his chapter and the archbishop, King. For the next six years he lived quietly, busying himself with his duties and writing only a few pieces, chiefly short letters of advice, articles on manners, etc. In 1716 he may have married Stella. The evidence is conclusive neither way, but the probability is against the marriage. At all events, she continued to live near him till her death in 1728, an event which caused him profound sorrow. Of the various, and occasionally heated, discussions that have arisen about this famous love story, the most sensible conclusion is that of Sir Leslie Stephen to the effect that the question is not practically important in determining the character and achievement of Swift.

In 1720 Swift again became active. For the next 18 or 20 years, until he could write no longer, his very voluminous production has three main aspects: that in behalf of the oppressed people in Ireland, both clergy and laity; that for the doctrines and the establishment of the Anglican Church; and the miscellaneous humorous and satirical writing, both in prose and verse, on which his popular literary fame largely rests. Beginning with a 'Proposal for the Universal Use of Irish Manufactures' (1720), he followed this with tracts on other subjects, and in 1724 began his most celebrated piece of polemic writing, 'The Drapier's Letters.' These very powerful, effective, but not wholly fair pamphlets were occasioned by a patent which had been issued to one William Wood to coin £108,000 of copper for circulation as small coin in Ireland. Swift, in the first three letters, addressed the people of Ireland, under various classes, and with much skill in the selection of arguments suitable to each class, advising them to shun the coinage which the English government was trying to foist upon the Irish public. Then, having prepared his ground, he launched forth, in the next three letters, against the general right of the English to exploit and oppress the Irish. He closed the series with a letter, not published till 1735, «An Humble Address to both Houses of Parliament,» in which he powerfully reviewed the woes of Ireland and made proposals for remedying them. The letters caused great excitement: the printer was arrested and a reward was offered by the government for the apprehension of the writer; but they produced their effect and the coinage was refused. Swift became very popular, and his position enabled him to pursue the subject of his last letter in many other tracts. The miserable condition of Ireland is the burden of his political song, in such able pieces as 'A Short View of Ireland' (1727), and 'Maxims Controlled in Ireland' (1728). The most remarkable of these minor pieces is the very extraordinary piece of irony, 'A Modest Proposal for Preventing the Children of Poor People in Ireland from being a Burden to their Parents or Country and for Making them Beneficial to the Public.' No more bitter or intense satire than this exists in literature: for 10 years Swift had been fighting oppression, and this is the highest pitch of his complainings. Nothing that he had previously touched on — the villainy of the landlords, the vanity and foppery of the women, the rigor of the English and the miserable state of the country in general — is left unexposed.

Swift's writings on religious subjects of this period are, on the whole, of less permanent interest than those just considered. They belong to a rather later date, when his interest in the general economic condition of Ireland had spent itself after its most vehement outcry, 'A Modest Proposal.' These writings are on two main subjects, the economic oppression of the minor clergy in Ireland and the efforts of the various sects of dissenters to obtain greater civil rights. Of the former of these the able tract "On the Bill for the Clergy's Residing on Their Livings" (1731–32), is representative. Specifically it is an argument against the plan of the bishops to get more power by compelling the lower clergy to divide their livings and to erect houses thereon at the direction of the bishops. In general, it is an acute comparison between the condition of the clergy in Ireland and in England and an exposition of the wretched condition of the former. It is said to have induced the commons to reject the bill after it had been passed by the lords. The same idea he expressed satirically, as was usually his practice, in 'An Essay on the Fates of Clergymen,' a piece which deserves a place with Hogarth's drawings of the idle and the industrious apprentices. Typical of the latter class is 'The Presbyterians' Plea of Merit' (1730 or 1733), in which he dismembered the claim of the dissenters to meritorious services in the time of the Commonwealth and the Revolution. The same subject he treated in his ablest satirical manner in 'Reasons Humbly Offered to the Parliament of Ireland for Repealing the Sacramental Test' (1733), in which he purported to show that in all respects the Catholics were more deserving than the Dissenters and should, therefore, have religious freedom. In all the many tracts of this latter class, he argued in favor of the actual establishment of the Anglican Church.

The third kind of work of this period consists of his miscellaneous satires, in prose and verse, and on one of these, 'Gulliver's Travels,' his popular fame chiefly rests. The idea may have originated in the days of the Scriblerus Club (see ARBUTHNOT), but took no definite shape till after 1720. The motive of the book is thus expressed in a letter to Pope, 29 Sept. 1725: "I like the scheme of our meeting after distresses and dispersions, but the chief aim I propose to myself in all my labours is, to vex the world rather than divert it, and if I could compass that design, without hurting my person or fortune, I would be the most indefatigable writer you have ever seen, without reading. When you think of the world give it one more lash at my request. I have ever hated all nations, professions, and communities; and all my love is toward individuals; for instance, I hate the tribe of lawyers, but I love counsellor such a one, and judge such a one; it is so with physicians (I will not speak of my own trade), soldiers, English, Scotch, French, and the rest. But principally I hate and detest that animal called man; although I heartily love John, Thomas, etc." The famous book appeared in November 1726, in London, whither Swift had gone in the spring of the same year. It was published anonymously and had instant success. It has since held its place as the most comprehensive and truculent satire and one of the most popular children's books in the English language.

In a letter to Pope, of 12 June 1732, Swift alluded to two pieces of satire which he had in mind and which are the only ones besides 'Gulliver's Travels,' which need be specifically mentioned. 'A Complete Collection of Genteel and Ingenious Conversation,' etc., commonly called 'Polite Conversation,' appeared in 1738; it is a well-sustained satire against cant and affectation in talk. The other, 'Directions to Servants,' a satire against slovenliness, remained unfinished at his death. They are about the last work that he did. During his visits to London he lodged near Mrs. Vanhomrigh, whose daughter Hester fell in love with Swift. She is the Vanessa of Swift's writings. She followed him to Ireland after her mother's death and resided near him at Celbridge. In 1723 she wrote to Stella but received a stinging rebuke from the dean. She died soon after. Her story is, perhaps, even more pathetic than that of the more patient Stella.

Swift's journey to London in 1726 for the sake of seeing his old friends, and one of the following year, on the death of George I, to determine whether the new ruler would aid his work for Ireland, were the only times when Swift left that country after 1714. Thence on he lived in Dublin in growing physical distress, and in 1738–39 his health began to fail seriously. For three years he was tortured with pain, and in 1742 his mind completely gave way, owing to disease which is said to have had nothing to do with his constitutional malady. Up to his death he was almost wholly imbecile.

For a long time a legend was current that Swift was buried in Saint Patrick's in the same coffin with Stella — a legend accepted by the 'Encyclopædia Britannica' and the 'New International Encyclopedia.' As a matter of fact the grave of Swift in Saint Patrick's, Dublin, is several yards distant from Stella's. In 1835 some alterations in the church disclosed Swift's coffin; a society of phrenologists happened to be in session in the city at that time, and obtained permission to examine Swift's skull and that found in a neighboring coffin, not Stella's. The lazy sexton, in returning the skulls, saved himself trouble by poking them both into Swift's coffin. A further exhumation in 1882 disclosed them together, whence the legend. For the disposal of this oft-repeated story consult article by Dr. H. J. Lawlor in the *English Historical Review* (March 1918).

Swift, in his maturity, is represented in the several extant portraits, of which those by Charles Jervas are the most interesting, as a man of large frame and handsome countenance. Contemporary accounts represent him as a man of much distinction of manner and powerful personality. Intellectually he was unquestionably among the greatest of his time, and his influence was uncommonly great. From the time of the 'Drapier's Letters' he exercised a remarkable sway over the affections of the

Irish, and is said to have been the most popular man in Ireland. By his friends he was greatly beloved and the charm which his personality has exercised on most of his biographers has frequently made them protagonists and led them to minimize some evident defects of his character, as his mercilessness to his opponents and his not infrequent coarseness, defects which he shared with many of the ablest men of his time.

Among all the able writers of the age he is surpassed by none in range and power and by none, except Defoe, in voluminousness. His known writings comprise over 230 separate prose titles, varying in length from the 'Meditations on a Broomstick' to 'Gulliver's Travels,' upward of 300 poems and some 500 letters. Within the limits of his style, which may be defined as the simple, intense and unadorned, as opposed to the ornate or the sublime, he is complete master of his medium and his sureness of touch in the large number of varied subjects that he treated, give him a place among the very greatest of English writers. Neither philosophical intricacy nor emotional appeal interested him, but as master of simple, racy English, of irony, humor, burlesque, satire and invective, he is unsurpassed, as he is also in his management of the topics with which he deals. Though he is remembered in literature chiefly for his great satires, nearly all the titles cited in the foregoing columns are models of their kind in writing. See BATTLE OF THE BOOKS; GULLIVER'S TRAVELS; TALE OF A TUB.

Bibliography.— The best editions of Swift's complete writings are still those of Sir Walter Scott in 1814 and 1824 (2d ed.) in 19 vols. The most convenient and accurate modern edition of the prose is by Mr. Temple Scott (begun 1898) in 12 vols. of the Bohn Library. Other editions and selections of his prose and verse are too numerous to mention specifically. The principal early biographies are Orrery's 'Remarks on the Life and Writings of Swift' (1752), Delany's 'Observations' (1754), Dean Swift's 'Essay upon the Life, Writings, and Character of Dr. Jonathan. Swift' (1755), Hawkesworth's 'Memoir' (1755), Johnson's in the 'Lives of the Poets' (1780), Thomas Sheridan's 'Life' (1784), Monck-Berkeley's 'Enquiry' (1789), John Barrett's 'An Essay on the Earlier Part of the Life of Swift' (1808), Sir Walter Scott's 'Memoirs' (prefixed to the edition of the works), all of which tell much the same story. Scott's is the best. Monck Mason's 'History and Antiquities of Saint Patrick's Cathedral' (1819), contains much interesting and valuable matter. The more modern and authoritative lives begin with John Forster's 'The Life of Jonathan Swift, 1667–1711' (1875), unfortunately unfinished. The most complete and accurate life is, on the whole, that by Sir Henry Craik (London 1882). Sir Leslie Stephen's in 'The English Men of Letters' is also good. Other lives are the enthusiastic study by J. Churton Collins (1893), the less interesting 'Dean Swift and His Writings' by G. P. Moriarty (1893) and the introduction to the Bohn Edition by W. E. H. Lecky. Consult also Smith, S. S., 'Dean Swift' (New York 1910); 'Correspondence,' edited by E. F. Ball (ib. 1914) and "The Bibliography of the Writings of Jonathan Swift" (in 'Prose Works,' Vol. XII, New York 1908); *English Historical Review* (March 1918).

WILLIAM T. BREWSTER,
Professor of English, Columbia University.

SWIFT, Joseph Gardner, American military officer: b. Nantucket, Mass., 31 Dec. 1783; d. 1868. In 1800 he entered the army as a cadet and in 1802 became the first graduate of the Military Academy at West Point. In 1807, having attained the rank of captain of engineers, he was appointed to the command of West Point. For meritorious services in the campaigns of 1813 and 1814 on the Saint Lawrence River, and in defense of the city and harbor of New York, he was brevetted as brigadier-general. General Swift was afterward surveyor of the port of New York for nine years, then civil engineer of the Baltimore and Susquehanna Railroad, and from 1829 to 1835, under appointment from President Jackson, superintendent of the harbor improvements on the lakes, removing to Geneva, N. Y. In 1838 he was chief engineer of the Harlem Railroad in New York, and in 1841 was sent by President Harrison on an embassy of peace to the governors of Canada, New Brunswick and Nova Scotia.

SWIFT, Lewis, American astronomer: b. Clarkson, N. Y., 29 Feb. 1820; d. 1913. He was graduated at Clarkson Academy in 1838. He became interested in astronomy, built his own telescope in Rochester, N. Y., and began to make observations. For years he searched the heavens for comets, and discovered the notable one of 1862. In 1869 he observed a total solar eclipse and secured valuable results. Two years later he found another comet, and in 1877-79 discovered other comets, for which he received a gold medal from the Imperial Academy of Sciences in Vienna. In 1882 he assumed the directorship of the Warner Observatory, and later took charge of the Lowe Observatory on Echo Mountain, California. Before the completion of the Warner Observatory, Dr. Swift was presented by the people of Rochester with a 16-inch refractor costing $11,000. With this instrument he discovered 900 nubulæ there and over 300 at Echo Mountain, California, and about a dozen comets at both places. In 1881 he was awarded the Lalande prize of the French Academy, and the Jackson Guill medal and gift of the Royal Astronomical Society in 1897. He also received several comet medals from the Astronomical Society of the Pacific. He wrote 'Lessons in Astronomy' (1888).

SWIFT, Lindsay, American editor: b. Boston, Mass., 29 July 1856. He was graduated at Harvard University in 1877 and became the editor of the Boston Public Library. Author of 'Massachusetts Election Sermons' (1897); 'The Great Debate Between Webster and Haynes' (1898); 'Literary Landmarks of Boston' (1903); 'Benjamin Franklin' (1910); 'William Lloyd Garrison' (1911), etc.

SWIFT, a local name in the eastern United States for the familiar fence-lizard (*Sceleporus undulatus*) in reference to the celerity of its movements. See SCELEPORUS.

SWIFT CREEK, or ARROWFIELD CHURCH, Engagement at. On 9 May 1864 General Butler sent an expedition from his intrenchments at Bermuda Hundred to destroy the railroad between Richmond and Petersburg. With a large part of the 10th and 18th corps Generals Gillmore and W. F. Smith moved out in the morning and destroyed the road from Chester Station on the north to Swift Creek on the south, a distance of six miles. Arriving at the creek and driving the Confederate skirmishers across it, the Federals found that the stream was not fordable and that the bridges were held by Hagood's and a part of B. R. Johnson's brigade, with artillery posted on the south bank. There was a sharp engagement across the stream, with artillery and infantry, in which each side lost about 150 men, and on the morning of the 10th the expedition returned to Bermuda Hundred. Consult 'Official Record' (Vol. XXXVI).

SWIFT-MOTHS, a cosmopolitan family (*Hepialidæ*) of large or medium-sized moths, characterized by brownish or golden wings, exceptionally white; a jugum is present, and the neuration of the fore and hind legs is similar. Their jaws are vestigial in the imago, and no food is eaten by the adults. The caterpillars bore into the stems of plants, live underground, and feed on roots; the "incomplete" pupæ also are subterranean. The hop-moth and the British ghost-moth are typical examples.

SWIFTS, birds of the family *Micropodidæ* (or *Cypselidæ*), noted for the extreme rapidity of their flight. Their proper place in the system of ornithology has been much discussed. Formerly they were universally classed with the swallows, but the usual opinion among ornithologists is that, unlike as are the swifts and humming birds (q.v.) in general aspects, they with the nightjars form a natural assemblage, the order *Cypseliformes*, or its equivalent. The swifts have a generally swallow-like aspect. The bill is very small, flat and weak, but the mouth, which is not provided with bristles, extends far back beneath the eyes, giving a very extensive gape. Just at its base above are the nostrils partly covered by feathers. The feet are very small without any distinct scaly covering or any comb-like claws, and they present remarkable peculiarities in the position of the hallux and the number of phalanges in the different genera. The wings are extremely long, reaching far beyond the tail and crossing, but the length lies entirely in the extremely elongated primary quills, the upper segments of the arm and the secondary quills being unusually small. In the typical swifts the tail is long and forked, in others it is short, truncate and spiny; there are always 12 retrices. Among anatomical characters swifts have the salivary glands remarkably developed and of the mucous type; the lower intestine has no cæca; the skull lacks basipterygoid processes in those which have the palate of the passerine (*ægithognathous*) type but has them combined with the cleft-palate (*shizognathous*) type; the keel of the sternum is remarkably deep and the pectoral muscles correspondingly well developed. Except that they shun the polar regions these strictly insectivorous birds are cosmopolitan in their distribution. There are about eight genera and 75 species divided into the subfamilies of *Micropodinæ* or typical swifts and the *Chaturinæ*, or spine-tailed swifts. The first has the tail feathers normal, the tarsi and toes feathered, the hind toe capable of being turned laterally or forward and the three front toes with only three joints each. Nearly all of the species of this group belong to the Old World, several being South American, and one belonging to the United States. In *Cypselus* all four toes are directed forward. To this genus belong the common swift of Europe (*C. apus*) and the Alpine swift (*C. alpinus*). The only representative of this group occurring within the United States is white-throated or rock swift (*Aëronautes melanoleucus*), found in the southwestern region north to Wyoming and in winter in Mexico and Central America. The hind toe is directed laterally, not forward, and the toes are only partially feathered. The colors are black above with some white markings and white below; the length about seven inches and the closed wing the same. This species is gregarious and nests in extensive colonies in holes and on ledges of inaccessible cliffs. Like the European swift its flight is incredibly rapid. Among exotic species of true swifts, none are of greater interest than palm swifts (*Tachornis*) of Africa and the tropical Orient and the aberrant tree swifts (*Macropteryx*) of India and Ceylon, which nest in trees.

The subfamily *Chæturinæ* has the feet more normal, but the hind toe is more or less versatile and the phalanges of the front toes, though not reduced in number, are extremely short; the feet are unfeathered and the tail feathers have the vane wanting at the end, the produced shaft forming a stiff mucronate tip. The common chimney swift (or erroneously swallow) (*Chætura pelagica*) is an example, and is too well known to require a description. It is a migratory species and one of the very latest birds to appear in summer. It breeds as far north as Labrador and winters southward to southern Mexico. Its western limit is the central plains. This is one of the birds which has been reputed to hibernate at the bottom of ponds and not a few circumstantial accounts of the manner in which they entered the mud have been published. Several patient, truth-loving, zoologists have carefully investigated these reports with the expected result that they proved baseless. The nests of this swift are interesting structures of twigs glued together with a thick coating of hard varnish-like dried saliva, which also serves to attach the saucer-like structure to the inside of an unused chimney, which at the present time are the almost exclusive nesting and sleeping sites of these birds. Formerly they occupied hollow trees and still do in unsettled parts of the country. The eggs are pure white and number four or five. Most of the life of these birds is spent in flight, and many and remarkable are their aerial performances. The only other swifts of this subfamily inhabiting the United States are *Chætura vauxii* of the Pacific States, there replacing the eastern chimney swift, and the black swift (*Cypseloides niger*) of the Rocky Mountain region and westward from British Columbia to Central America. It ascends to great altitudes. Several species of the latter genus occur in South America. *Callocalia* includes the edible birds'-nest swifts (q.v.) of which a number of species occur from southeastern Asia to Madagascar and the Marquesas.

Consult, besides the articles referred to above, and the standard works on American

Ornithology, especially Hartert, 'Catalogue Birds British Museum' (Vol. XVI, London 1892) and 'Cambridge Natural History' (Vol. IX, New York 1907).

SWIMMING, the art or practice of locomotion or mode of progression in the water by using the arms and legs as paddles. According to the best authorities, all animals, excepting man, monkeys and, perhaps, the three-toed sloth (*Bradypus Tridactylus*), either swim naturally or go through the motions of swimming when suddenly immersed in water. There are, however, a number of animals that, although they swim naturally, drown as they swim. This is the case with rabbits, mice, moles and the smaller cats. Drowning appears to be the result of the fur being saturated. Tigers, cheetahs and lions, the larger cats, are fine swimmers. It is noteworthy that the mole and the rat are equally strong swimmers, the former, however, drowns in a short time, while the latter has considerable endurance in the water and is credited with many feats of long-distance swimming.

The conditions under which an animal will swim well are those in which the wetted surfaces are large and, therefore, afford the greatest power of resistance, and where the specific gravity of the object is a little greater than that of water and consequently subject to the least disadvantageous displacement. Almost all of the larger quadrupeds, especially the deer and the horse, are exceptionally fine swimmers. They simply walk in the water, the motions which serve to support and propel them in that medium being very similar to those employed to progress on land.

On the other hand, in the swimming of man, it is necessary to consider a semi-artificial mode of progression, which is, however, subject to and regulated by the general laws governing aquatic locomotion in relation to the medium, the body immersed therein and to the forces exerted by that body to propel itself. The human body with a normal amount of air in the lungs is very slightly lighter than water and the movements of the limbs produce various effects, according to the direction of the effort. When they are moved horizontally and downward they tend to support and propel the body. When they are moved in an upward direction, as in diving, the body is given a tendency to descend. As to the immersed surfaces, their direction tends to either float or sink the body. When a man wishes to float in the water he assumes a flat position resembling the natural position of the lower swimming forms and for purposes of propulsion and support employs the "dog paddle," in which the motions of the hands are exactly similar to those of the forepaws of a dog in swimming or in walking; a method of swimming employed naturally by almost all land animals.

Although a man's initial efforts to swim result in positions of the body and motions of the limbs which closely approximate to those of the lower animals that swim naturally, he has adopted and developed artificial methods by the use of which he surpasses them in speed and endurance.

These methods involve motions of the limbs which may be conveniently designated as the breast or front stroke, the side stroke, the overhand stroke, swimming on the back, diving, floating and treading. In general, so long as the arms and legs move in any direction, the forces exerted tend to propel the body.

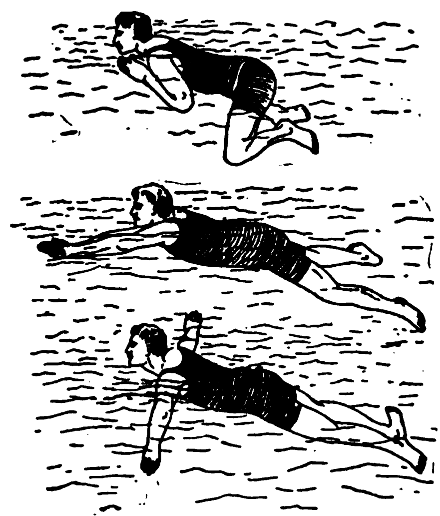


FIG. 1.— Breast Stroke.

The breast stroke consists of a broad sweep of the arms in a horizontal plane, accompanied by a frog-like motion of the legs. It is commenced by placing the hands with the backs upward, the wrists being bent sideways so that the fingers point to the front and the inner sides of the wrist joints touching the breast about four inches below the surface of the water. The arms are then pushed gently forward, the palms being kept flat and the fingers closed. When the arms have been extended to their full extent, the palms of both hands are turned outward and a strong outward sweep is made by each arm, horizontally, through an angle of 90°. The arm movement is completed by bending the elbows backward and inward until they are brought close to the sides of the body and then the hands are carried edgeways, to their original position in front of the body. Simultaneously with the extending of the arms to the front, the feet are struck out backward and spread wide apart and as the arms are swept around, the lower limbs are stiffened and brought firmly together so as to grasp the water by the whole leg, thus imparting a forward movement to the swimmer and also finishing in a straight line behind the body. Then, when the arms are bent and the hands are being brought to their original position in front of the body, the knees and toes are turned outward, the heels are kept close together and the feet are carried up to the body to repeat the movements.

The breathing is effected in a natural and unrestrained manner. A full breath is taken at every stroke and regulated so as to avoid gasping on short heavings, by exhaling as the arms are being extended and inhaling as they are being swept around.

In swimming with the side stroke, the body may be turned upon either side and by changing from one side to the other the swimmer rests his muscles somewhat. In side swimming, the deeper immersion of the head reduces its weight and relieves, somewhat, the strain of its support from the muscles of the neck. If on the right side the right arm is thrown out in front with the palm of the hand turned downward and kept level with the under side of the head. It is then pushed out to its full extent, kept rigid and without bending either

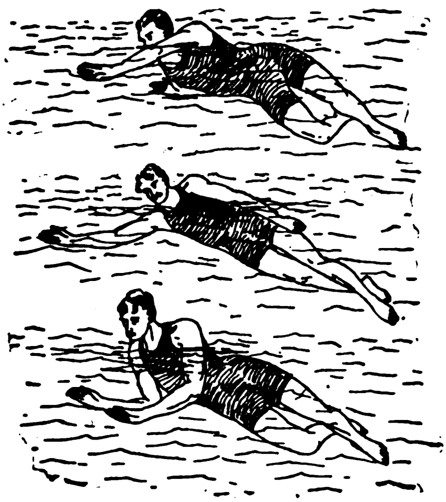


FIG. 2.— The Side Stroke.

the wrist or the elbow, is brought down through the water in a strong movement until the hand at full stretch comes between the legs. It is then brought up along the body to the chin and the stroke repeated. The left hand, formed into a scoop, is turned outward by the wrist at right angles to the forearm and the left arm, with elbow bent, is thrown outward and executes a straight pulling stroke to the left hip. The arms act alternately and when one is executing the positive, the other is at the negative part of the stroke. The action of the legs should be long and powerful and coincident with that of the arms and shoulders. When the right arm finishes its downward stroke and the left arm is extended in front, the legs are drawn up to the body. When the left arm pulls downward, the legs are opened wide, swung around and closed, in one continuous motion. Care is taken never to cross the legs, make any effort to raise or sink the head, or exert any sudden pull at any part whatever of the complete stroke.

In the overhand stroke, all the movements excepting those of the upper hand and arm, are similar to those of the side stroke. The left or upper arm is brought forward and extended as far as possible out of the water in front of the head, then dipped and pulled through with a strong propelling stroke. The method gives a more lengthened reach and when properly acquired, is the most useful and easy of all the various methods of swimming; but the side stroke is the one generally employed in long-distance racing.

One of the fastest strokes for short-distance swimming is the Trudgeon stroke, introduced into England a few years ago from the South Pacific. The action of the arms consists of alternate overhand strokes, while the legs made a frog kick simultaneously with one of the arm strokes, with the body swimming on the belly. A modification of this style was introduced a few years ago by Meffert, the American mile champion, and has been adopted by some of the best American swimmers. In it the head and the forearm are kept submerged when the body is being pushed forward and

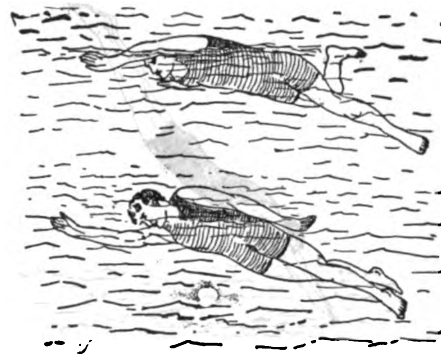


FIG. 3.—Bracing Stroke.

the face is brought out of the water to breathe, by a turning action of the waist as the forward movement checks between the strokes. This style prevents a cramped position of the head and also allows a freer action of the body. Many racing swimmers take a breath only every other stroke, keeping the face half under water half of the time.

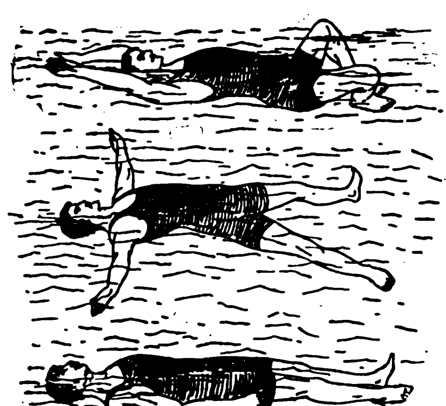


FIG. 4.—Swimming on the Back.

Swimming on the back is accomplished by lying in the water back downward, the hands resting on the waist, the elbows directed outward, the breath held and the chest expanded. To propel, the legs are bent and the feet are drawn up close to the trunk, the knees being directed outward with the heels close together. The legs are now struck out as wide apart as possible and then brought closely together until the great toes, inner ankles and the inner sides of both legs meet along their entire length. Greater speed may be obtained by extending the arms outward and on a level with the body, the palms facing downward and using them as sculls.

Diving, when well performed, is a very graceful feat. The dive may be a standing or a running one. To make a good dive, the feet line and legs are kept close together, the chest inflated and the arms are swung back and forth two or three times. The lungs are then charged

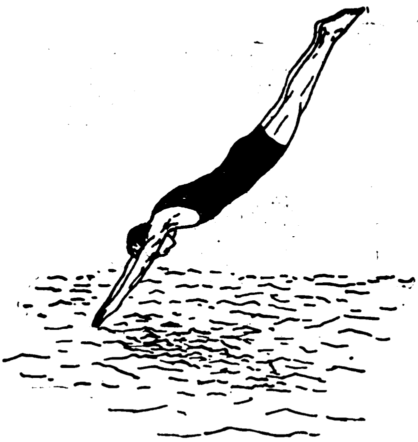


FIG. 5.—Diving.

with a long, deep breath, and the dive is made just a moment before the arms and hands are raised over the head. In springing off, all the power of the legs is used, and in mid-air the body is straightened out like an arrow from the tips of the fingers to the toes. The arms are then declined so as to enclose the head, the chest is contracted for an instant and the water is entered noiselessly and without a splash, fingers first. The moment the body is covered, the head and arms are thrown up, which brings the diver to the surface. The eyes, which instinctively close as they enter the water, should be opened under the water, in order to avoid accidents.

Floating is the position assumed by a swimmer to rest. It is accomplished by holding the forehead below and the mouth and chin above the surface of the water. The arms and legs may be stretched out as far apart as possible, as in the «spread eagle» position or the body may be held rigid and straight with the legs crossed, the lower part of the face and the toes peeping above the water and the arms either lying at the sides or above the head with the thumbs locked.

Treading water is a method employed to maintain a perpendicular position in the water, the head being kept above the surface. It is accomplished by paddling with the hands and working the legs and feet as if going up stairs, with the soles of the feet acting as sustaining surfaces. It is the only branch of the art that approaches natural conditions and if resorted to in cases of accidental immersion, would prevent 75 per cent of the deaths due to that cause.

Expert swimmers are capable of dispensing with the use of the arms, and when treading for display, or in competitions, either hold their arms and hands above the surface or fold them across the chest. They are also capable of floating with both legs or both arms out of the water; spinning like a top while maintaining a sitting position; taking off the clothes on the body; taking off the stockings, and cutting the toe nails, all of which illustrate man's command over the attending artificial conditions.

Aids to increase speed may be employed in the form of wooden plates which are attached to the palms of the hands and the soles of the feet. The most effective are those invented by R. H. Wallace Dunlop and introduced in England in 1876. Other helps, for sustaining purposes, have been employed from very early times. They were generally in the form of flat surfaces of wood, tin and water-proof fabrics, but their use is not recommended.

The Amateur Athletic Union of the United States holds championship swimming competitions in various places every year. The Hawaiian Association has a very large following and holds numerous contests. There are also intercollegiate, metropolitan and many local competitions.

A general idea of the speed and endurance of swimmers may be obtained from a few of the best performances on record: 100 yards — P. McGillivray (American amateur), 54s. (in bath); D. P. Kah'oku (American amateur), 53s. (in open water); A. Wickham (Australian professional), 1m. 4⅘s. (in open water).

One mile — D. Billington (English professional) 24m. 11⅗s. (in open water); B. Kieren (Australian amateur), 23m. 16⅘s. (in bath); G. R. Hodgson (Canadian amateur), 23m. 34½s. (in open water). Woman's record — Fannie Durack (Australian), 26m. 8s.

Long-distance swimming — Webb, 40 miles with tide, 9h. 57m. 00s.; Mercardier, 20 miles with current, 4h. 59m. 46s.; Miss Agnes Beckwith, 20 miles with current, 6h. 25m. 00s.

Long immersions — Webb, 20 miles, increased to 35 miles by tides, crossing the English Channel, 21h. 45m. 00s.

Bibliography.— The literature on swimming is quite extensive. The following-named works are among the best on the subject: Thevenot, 'The Art of Swimming' (trans. London 1699); Bermordi, O. de, 'Schwimmkunst übersetz' (Vienna 1797); Frost, J., 'The Art of Swimming' (New York 1818); Rompelman, H., 'Het nut der Zwemkunst' (Amsterdam 1830); Fontenelle, Julia de, 'Manuel des Nageurs' (Paris 1838); Forrest, George, 'Handbook of Swimming and Skating' (London 1865); Leahy, John, 'The Art of Swimming in the Eton Style' (London 1875); 'Spaulding's Athletic Library,' Nos. 20–30 (New York 1894–95); Dalton, Capt. Davis, 'How to Swim' (New York 1899); *American Physical Review* (Vol. IV, Cambridge, Mass., 1899). Consult also Austin, H. R., 'How to Swim' (London 1914); Brewster, E. T., 'Swimming' (Boston 1910); Dalton, F. E., 'Swimming Scientifically Taught' (New York 1912).

SWIMMING BLADDER, AIR-BLADDER, or SOUND, an internal sac-like organ in fishes by which they regulate their relative buoyancy. See FISH.

SWINBURNE, Algernon Charles, English poet: b. London, 5 April 1837; d. 10 April 1909. He was the son of Admiral Charles Henry Swinburne, of an old Northumbrian family, and Jane Henrietta, a daughter of the 3d Earl of Ashburnham, a woman of high culture who exercised a marked influence on the intellectual development of the poet during his earliest years. From Eton he went to Balliol College, Oxford, where his time was chiefly given to the study of Greek poetry and in less degree of the literatures of France and Italy. He wrote, also, for the *Undergraduate Papers*, a student publication, and seems to have produced a considerable body of verse which, however, he later characterized as worthless. He left Oxford in 1860 without taking a degree and traveled for a short time on the Continent, visiting Walter Savage Landor in Florence, for whom he entertained a great admiration. The year of his leaving Oxford was marked by the publication of 'The Queen Mother' and 'Rosamond,' which, written in the Elizabethan manner, revealed little metric talent and aroused practically no attention. In 1862 Swinburne settled in London, in the house of Dante Rossetti. In 1865 appeared his first and, according to many, his masterpiece, 'Atalanta in Calydon,' which was hailed as giving promise of a poetic genius of the highest rank. In the 'Atalanta' Swinburne displayed for the first time that magical mastery of metrical form in which, in all English literature, he is equaled by Shelley and Milton alone, if by them. In the celebrated choruses of the poem the English language is molded to an exquisiteness of lyric melody which might almost have been deemed impossible in a vernacular dominated by the stiff *imperium* of the Iambic verse. 'Chastelard,' a play dealing with an incident in the life of Mary Stuart, appeared shortly after 'Atalanta,' but was received with marked disappointment. The next year, however, came the 'Poems and Ballads,' which made Swinburne at once a figure of national and international note and the centre of a hurricane of criticism aroused by what might be called the ethical tone of the volume. The 'Poems and Ballads' showed the art of the author of 'Atalanta' at its best, but they sang of themes abhorred by middle class Anglo-Saxon morality, in a manner undeniably thorough. The animal side of sexual passion was therein depicted with a fervidness of tone and a wealth of fleshly imagery which subjected the poet to the most virulent denunciation as a glorifier of pre-Christian morality. As a matter of fact the 'Poems and Ballads' were chiefly intended as a protest against English Philistinism and do not in any way represent the ethical standards of the poet, whose mind on the contrary turns most often to the contemplation of love idealized, however much material beauty may inspire him. The taint of Anacreontism has nevertheless lingered in Swinburne's reputation and is possibly the most salient characteristic of his work to the casual reader. 'A Song of Italy' which appeared in 1867 definitely marks Swinburne's entrance into the field of political lyricism. He sang liberty with the same passionate utterance, though not with the same poetic success, with which he had sung of earthly love, and the theme is continued in his 'Ode on the Proclamation of the French Republic,' 'Songs before Sunrise' (1871) and 'Songs of Two Nations.' About this time he fell under the influence of Victor Hugo, whom he regarded with a feeling amounting almost to adoration, and indeed, in the various phases of his development, the want of measured restraint is striking. 'Bothwell' (1874) is the second part of a trilogy dealing with the fortunes of the unhappy Scottish queen, of which the first part is the 'Chastelard,' already mentioned, and the last, 'Mary Stuart,' published in 1881. In 1876 came 'Erechtheus,' a tragedy formed after Greek models and revealing, as 'Atalanta' had done, his marvelously sympathetic insight into the ancient Hellenic spirit. A second series of 'Poems and Ballads' appeared in 1878 and 'Songs of the Springtides' in 1880. 'Tristram of Lyonesse' (1882) contains some of Swinburne's happiest harmonic effects; the heroic couplet is there freed from its almost mathematical rigidity and precision and made to assume a vague softness of cadence that brings it near to the more flexible forms of lyric verse. Swinburne's work after 1882 shows no artistic progress as a whole. In all the perfect manner is apparent and the poet's resources never fail — and in some there are passages and sketches of an exquisite beauty equaling his best work; but beyond the height which he had earlier attained, he does not go. These works are 'A Century of Roundels' (1883); 'Marino Faliero,' a tragedy (1885); 'Locrine,' a tragedy (1887); 'Poems and Ballads,' 3d series (1889); 'The Sisters' (1892); 'Astrophel' (1894); 'The Tale of Balen' (1896), and 'Rosamond, Queen of the Lombards' (1899); of these Balen perhaps ranks nearest to the great works of his earlier period.

Swinburne also wrote much prose, in the field of criticism, possessing many of the characteristics of his verse, vehemence, imagery and lack of self-restraint. Although he possessed the gift of the illuminative phrase and displays at times a profound insight, his critcism as a rule shows no refinement of judgment. It was his avowed conception of the mission of criticism not to weigh narrowly and to examine minutely, but generously to praise. But though Swinburne was so far untrue to his position in that he sometimes hated as well as loved, he hated and loved with unrestrained passion. He wrote eulogies on 'Charlotte Bronte' (1877), 'Shakespeare' (1880); 'Victor Hugo' (1886), and 'Ben Jonson' (1889). To Robert Buchanan's assault on the 'Fleshly School of Poetry,' including Swinburne, Rossetti and Morris, the first replied in his scathing 'Under the Microscope.' Among his other works of criticism are 'Essays and Studies' (1875); 'Miscellanies' (1886), and 'Studies in Prose and Poetry' (1894). Mention should also be made of 'The Modern Heptalogia,' a volume of parodies on contemporary poets, which appeared anonymously in 1881 and has not been, as yet, officially acknowledged as a work of Swinburne. His it was, however, by common consent and that in spite of the fact that among the most amusing burlesques is the one on himself. Swinburne's position in English literature is to be assigned him on his merits as a master of verse form and poetic rhetoric. With no especial profundity of thought, with no definite theory of life, with no deep insight into human character, he stood pre-eminent as a molder of exquisite melodies. It is his manner that should give him a permanently high rank among English poets. (See ATALANTA IN CALYDON). Consult Wrateslaw, Theodore, 'Algernon Charles Swinburne, a Study' (London 1900); Shepherd, R. H., 'The Bibliography of Swinburne' (ib. 1887); Mackail, J. W., 'Swinburne' (Oxford 1909); Thomas, Edward, 'Swinburne' (New York 1912); Drinkwater, John, 'Swinburne: An Estimate' (ib. 1913); Woodberry, G. E., 'Swinburne' (ib. 1905).

SWINDON, England, in Wiltshire, 29 miles northeast of Bath and 76 miles west of London, consists of two parts — old and new Swindon. The older section on a hill is picturesque and its principal buildings comprise the parish church, town-hall, assembly rooms and corn exchange. The new town on reclaimed lowland contains a mechanics' institute, theatre, etc., the railroad shops of the Great Western Railway employing several thousand men and an extensive park connected with these works. The town is an important railway junction. Pop. 50,751.

SWINE. General Information.— Swine are of immense importance in the commerce of the world. In the United States alone there are some 65,000,000 of swine on the farms and in the hamlets. This figures some two-thirds of a hog for every human being in this nation.

Swine products are many and various,— fats, particularly lard, is one of the chief productions. A real fat hog produced on corn in the pastures of the corn belt may yield as much as 50 pounds of fat in every hundred pounds of his live weight; hams which are eaten fresh, boiled, fried, cured with hickory and other smokes, are relished the world over; bacon, the toothsome breakfast dish of Anglo-Saxons, has no substitute; sausages; spare ribs; pepsin extracted from pigs' stomachs for the medicinal doctoring of human stomachs; the bristly coat is used for brushes and as filler for cushions; the bones are ground for fertilizer; the hide is made into leather; in truth every ounce is utilized, nothing goes to waste.

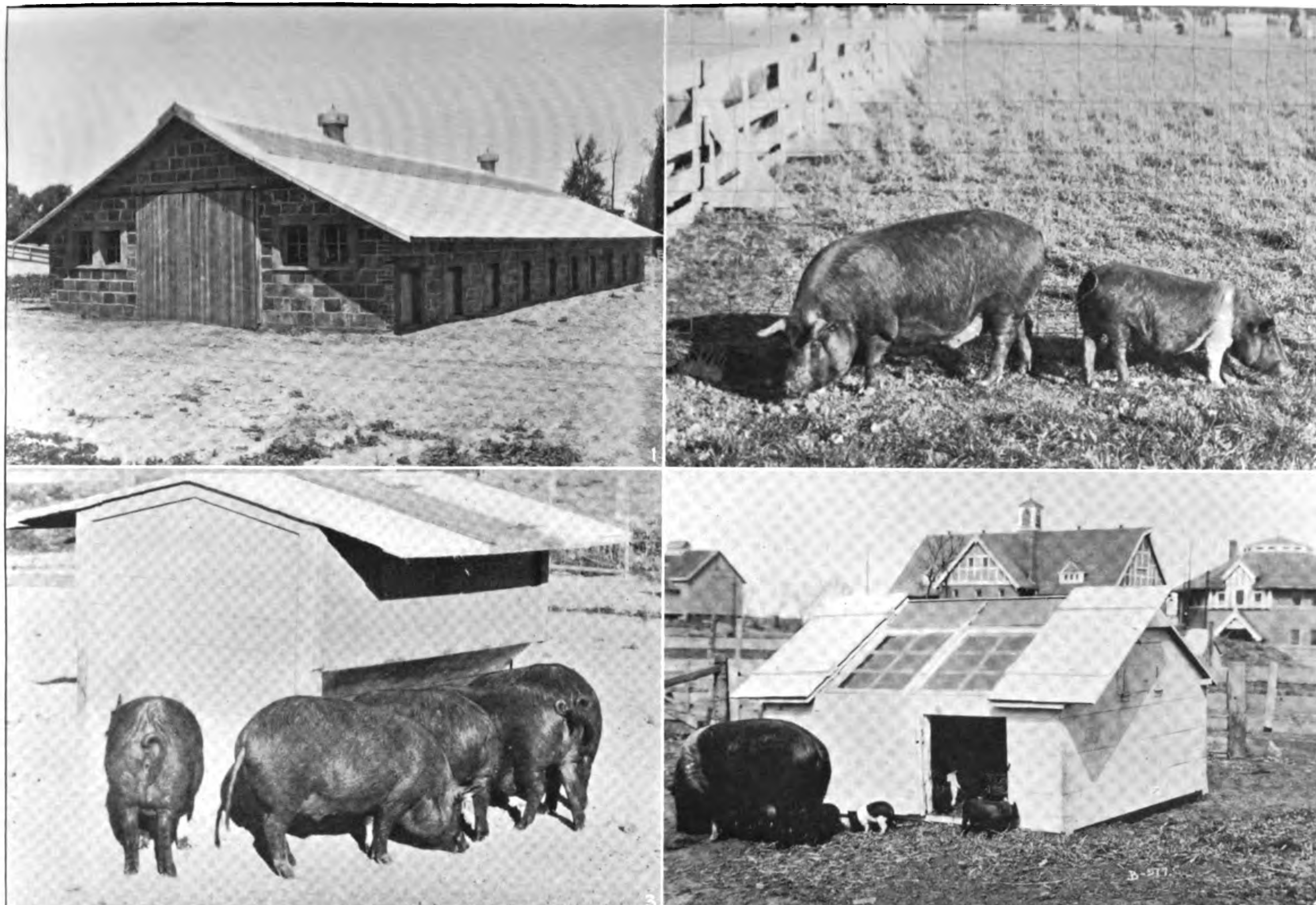
The source of the hog is shrouded in considerable mystery, although the true swine, the wild boar and his kind (*Sus scrofa*), probably developed in the Asiatic continent. Fossil remains have been found in Europe and India although not on the North American continent. The Peccaries found in Mexico and other southern countries are not to be confused with the true domesticated hog that is of such great commercial value. The Peccary is of American origin. The historic swine, therefore, that gave rise to the present day common hog may be basically considered as the wild boar (*Sus scrofa*) with which was infused in the early days the swine of China, Japan and eastern Asia (*Sus Indicus*). An eminent Chinese scholar estimates that swine were domesticated in eastern Asia about 2900 B.C., whereas the European records indicate a period of domestication about 1500 B.C. To these early efforts of the human race we owe much for the improvement and development of the now-a-day swine.

The flesh of swine has been used by all peoples apparently who came in contact with them. The Greeks and the Romans were adepts of the fine art of preparing and serving pork.

Pork is of particular advantage to civilized peoples in that it can be preserved by salting, smoking and other forms of cures so that it may be kept in edible condition for many years. Hams rightly cured appeal more and more to the epicure as the years unfold, so that hams five and six years from the "killing" are particularly appetizing. In the ordinary consumption of pork, however, hams seldom reach their first birthday before being eaten. Salt pork and smoked meats from the pig are shipped all over the world and many a nation owes considerable of its prosperity to its pork commerce.

Types and Breeds.— The domestic hog is entirely different from his wild progenitors. And yet domestic swine are widely different even among themselves as regards their general body conformation. Swine have been produced to meet the demands of the market as well as to fit into certain environments so as to utilize the home-grown feeds to the greatest advantage. We have, therefore, two great predominating types developed to their highest efficiency in Europe and particularly America,— these being the so-called bacon and lard types. Naturally the bacon hog is fine for bacon and lean meat in general, while the lard hog is best for fat (lard) and fatty sausage. The bacon hog flourishes in those sections where there is an abundance of small grains such as barley, oats, wheat and plenty of milk, whereas the lard hog is primarily of American origin, developing simultaneously with Indian corn or maize, a feed most excellently adapted to the production of fat, being highly concentrated and composed of these materials, namely the starches and fats, that are converted through the pig's metabolism into the lard and corn belt pork sausages. Denmark, England and Canada are all good bacon type regions,— Denmark principally because of her milk by-products and England because of her excellent pastures and cereals and Canada because of her cereal grains and milk products.

Contrast the original wild hog with the every-day American lard hog. The wild hog is narrow, more like one's hand viewed edgewise, but the lard hog is wide, certainly chubby in contrast; the former is relatively small in comparison. In short, the lard hog is not only wider and larger, but longer, better "hammed," shorter nosed, shorter "legged," more compact in body, shorter tusked and not nearly so ferocious and speedy of foot. Too, the lard hog has a better quality of meat and a much higher proportion of those most highly prized cuts of meat in proportion to the total weight, this being marked in the development of hams and loins, taken from the rear parts. Persistent selection of these animals for breeding purposes that most nearly approached the desired type has made it possible in the long years of endeavor to develop such a contrast in type. The development of this lard type is all the more remarkable in that the very characteristics which make up this type are supposedly inimical to the best health and bodily interests of the hog. Too much fat decreases vigor and vitality, and we are not surprised to find that the bacon types are much more active and virile, because they are not unduly fattened, in truth the general selection in this bacon pro-

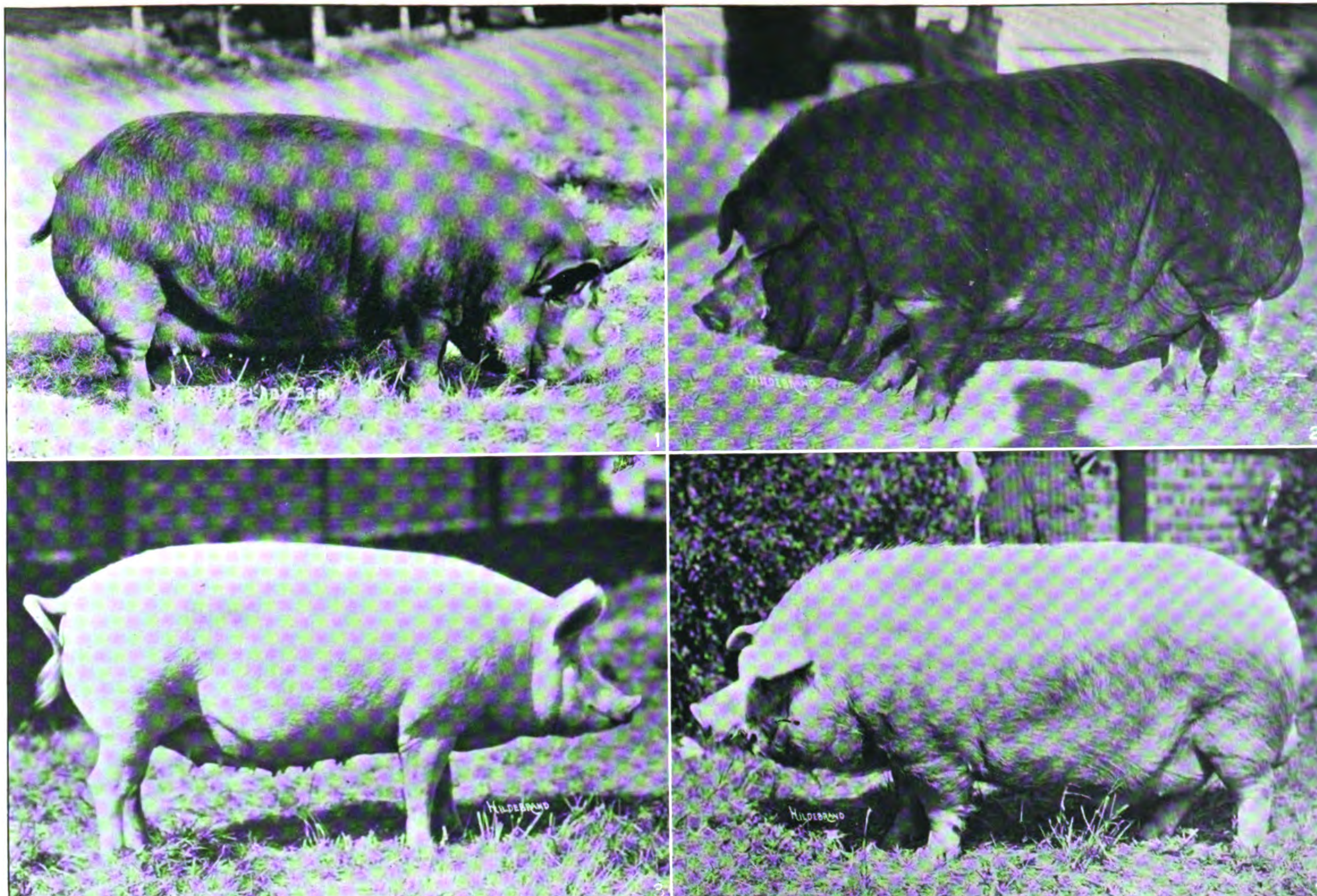


1 The Iowa Community Sunlit Hog House. Here is a new kind of hog house — one substantially but economically built for swine. It is a sanitary, economical and serviceable house of pleasing appearance

3 The Self-feeder method of feeding grains is efficient

2 The system of feeding is responsible for the difference in size — the large shote had all the corn he wanted on alfalfa pasture, and the little one only one-fourth of a full ration. It pays to feed swine liberally

4 The Iowa Movable Sunlit Hog House, well lighted, sanitary, convenient, economical, serviceable and durable



1 A Lard type — the Chester White — a white breed
3 A Bacon type — Yorkshire Gilt — a pure white breed

2 A Lard type — Poland China Boar. Note black color and white markings
4 The General Purpose type, both for bacon and for lard as shown in Berkshire breed by a sow

ducing business has been to develop muscular tissue, the chief emphasis being placed on its proper distribution with some, not too much fat, to make the most acceptable slab of bacon and the nicest "trimmest" hams, hams that do not require "too much trimming away of the fat."

The typical bacon breeds are Tamworths and Yorkshires. The Berkshires may be so classed because they yield the highest quality of bacon, but the Berkshire is sometimes placed in the general purpose class, good for bacon and good for lard. Then there is the Large Black of England.

The typical lard type breeds are Poland China, Chester White, Duroc Jersey, Victoria, Cheshire, Essex and Suffolk.

The general purpose breeds may be classed as the Berkshire, Hampshire, Mule-Foot and possibly the Middle White.

The score card method of teaching judging is in vogue in all of our leading agricultural colleges. A hundred points make up the total or the ideal, and the relative emphasis to place on the different parts is indicated by the number of points as given for perfect. Below are given representative score card values as used by the Iowa State College at Ames, covering the bacon and lard types in the barrows. The relative descriptions show where the emphasis is placed in each type.

BACON HOGS.

SCALE OF POINTS — FOR BARROW	Perfect score
General appearance:	
1. Weight, 170 to 200 pounds, the result of thick cover of firm flesh	6
2. Form, long, level, smooth, deep	10
3. Quality, hair fine; skin thin; bone fine; firm covering of flesh without any soft bunches of fat or wrinkles	10
4. Condition, deep, uniform covering of flesh, especially in region of valuable cuts	10
Head and neck:	
5. Snout fine	1
6. Eyes full, mild, bright	1
7. Face slim	1
8. Ears, trim, medium size	1
9. Jowl, light, trim	1
10. Neck, medium length, light	1
Forequarters:	
11. Shoulders, free from roughness, smooth, compact and same width as back and hindquarters	6
12. Breast, moderately wide, full	2
13. Legs, straight, short, strong, bone clean, pasterns upright; feet medium size	2
Body:	
14. Chest, deep, full girth	4
15. Back, medium and uniform in width	8
16. Sides, long, smooth, level from beginning of shoulders to end of hindquarters. The side at all points should touch a straight edge running from fore to hindquarter	10
17. Ribs, deep, uniformly sprung	2
18. Belly, trim, firm, thick without any flabbiness or shrinkage at flank	10
Hindquarters:	
19. Hips, smooth, wide; proportionate to rest of body	2
20. Rump, long, even, straight, rounded toward tail	2
21. Gammon, firm, rounded, tapering, fleshed deep and low toward hocks	8
22. Legs, straight, short, strong; feet medium size; bone clean; pasterns upright	2
Total	100

LARD OR FAT HOGS.

SCALE OF POINTS — FOR BARROW	Perfect score
General appearance:	
1. Weight, score according to size	6
2 Form, deep, broad, low, long, symmetrical, compact, standing squarely on legs	10
3. Quality, hair silky; skin fine; bone fine; mellow covering of flesh free from lumps and wrinkles	10
4. Condition, deep, even covering of flesh and fat over all parts of the body	10
Head and neck:	
5. Snout, medium length, not coarse	1
6. Eyes, full, mild, bright	1
7. Face, short, cheeks full	1
8. Ears, fine, medium size, soft	1
9. Jowl, strong, neat, broad	1
10. Neck, thick, medium length	1
Forequarters:	
11. Shoulder, broad, deep, full, compact on top	6
12. Legs, straight, short, strong; bone clean; pasterns upright; feet medium size	2
Body:	
13. Chest, deep, broad, large girth	4
14. Sides, deep, lengthy, full; ribs close and well sprung	6
15. Back, broad, straight, thickly and evenly fleshed	10
16. Loin, wide, thick, straight	8
17. Belly, straight, even	4
Hindquarters:	
18. Hips, wide apart, smooth	2
19. Rump, long, wide, evenly fleshed, straight	2
20. Ham, heavily fleshed, plump, full, deep, wide	10
21. Thighs, fleshed close to hocks	2
22. Legs, straight, short, strong; bone clean; pasterns upright; feet medium size	2
Total	100

There are a great many swine terms that need defining. A few of the important ones used in swine husbandry are given:

Swine: General name for any or all of the domesticated, omnivorous, suoid mammals supposedly descended from the *Sus scrofa* or *indicus*, or infusion of the two, more specifically known as Duroc Jerseys, Poland Chinas, Chester Whites, Berkshires, Hampshires, Tamworths, Yorkshires and other established breeds with their various cross-bred and mongrel breedings. Untamed wild animals are referred to preferably as "Wild swine."

Hog: May be used synonymously with the term "Swine" but refers preferably to marketable animals.

Gilt: Young, immature, prospective swine mother.

Sow: Female swine after producing young.

Boar: Well-developed male swine suitable for breeding service.

Boar Pig: Young male swine under breeding age, usually under six months old.

Stag: Swine castrated ("desexed") after the noticeable development of the secondary sexual characters such as tusks, shields, enlarged sheath, crest and others. Stags are docked 70 pounds on the large markets.

Barrow: Swine castrated before the sexual characters develop to a noticeable extent.

Pig: May be used synonymously with swine but preferably in America refers to those under three months of age. In England, Canada and Australia, pigs are swine of any age or weight.

Shote: Immature swine of either sex, except boar pigs, usually weighing from 60 to 175 pounds.

Weanling Pigs: Young pigs after weaning time.

Suckling Pigs: Young pigs following their mother and yet unweaned.

Pork: The dressed meat of swine used for food.

Management and Handling.— In the housing due attention must be paid to these essentials: Warmth, they do not thrive in real cold and freezing quarters; dryness, if kept in damp quarters contract various ills such as rheumatism and stiffness; abundance of diffused light; much direct sunlight, appropriately so for the new-born offspring to give them strength and stamina; shade, especially in the very hot months; ventilation, to insure fresh pure air; sanitation, to prevent diseases; safety; comfort; convenience, this being true not only for the swine but for the caretaker. Swine should not be compelled to unnecessarily exert themselves, unless it be at certain time when particular advantages are to be gained thereby for the herdsman; serviceability; sufficient size to shelter advantageously; durability; reasonably low first cost; minimum cost of maintenance; and pleasing appearance so as to harmonize with the general surroundings adding by all means to the artistic and architectural beauty of the community.

In the feeding, the ration must be well balanced else the swine will not thrive. Corn alone in dry lot, even though plenty of water be supplied, together with salt, is deficient, in that it does not supply all of the nutritional factors necessary for the growth and well being of the pig. To illustrate, well-nourished swine eight months of age can be made to weigh 300 pounds, but they must have a balanced ration to do this,— such as corn, maize and milk (skim, butter or whole); or corn and alfalfa or clover or rape pasture together with a little meat meal; or corn and meat meal, both being fed in separate open containers, same being kept filled with feed and before the swine at all times. «Corn-alone fed» pigs at eight months old fed by the Iowa Experiment Station weighed 57 pounds, and yet the first three months of this feeding time the pigs had a good ration. Similar pigs fed on corn and meat meal from the packing houses weighed 225 pounds. The corn pigs required 1,447 pounds of corn for 100 pounds of gain, but the ones receiving meat meal in addition needed only 366 pounds of corn plus 48 pounds of meat meal, a total of only 414 pounds of concentrated feed. Less than a third as much feed was required where the properly balanced ration was fed. It is wise and proper to vary the ration, giving equitable feeds in the right proportions and thereby giving the pig a chance to develop properly. Both the art and the practice of swine feeding are learned only by much experience mellowed with keen insight into the psychology and the nutrition of interesting but oftentimes perplexing animals.

The costs of production that enter into the making of marketable hogs centre around these import items: Feed, such as the grains; pasture; equipment covering houses, troughs, fences and other details; man labor; horse labor; interest on the capital invested, and general miscellaneous or overhead expense. To give a comprehensive idea as to the distribution of these costs in the heart of the swine-fattening and producing region, namely the corn belt, there is presented herewith the distribution of the total cost, or 100 per cent among the mentioned items:

	Per cent
Feed grains grown and purchased	84
Pasture to supplement grains, also lot rent	4
Man labor	4
Interest on the investment or capital	4
Horse labor	1
Equipment upkeep	1
Overhead expense	2
Grand total expense	100

The Swine Commission of the United States Food Administration in the year 1917 found that it took the equivalent value of 12 bushels good number two corn grain to produce for market the average hundred pounds of marketable hog, delivered to the Chicago, the basic and general controlling hog market of all the world. This counts the costs of all items entering into the keep of the herd. Definitely, therefore, this means that if number two corn grain is worth a dollar a bushel at Chicago that the farmer who ships to that market will not on the average make any money unless he gets over $12 a hundred pounds for the live hogs. The good farmer will of course produce them more cheaply, but when the costs can be put down to the 11-bushel basis that is very good indeed. Of course the man who feeds garbage, the kitchen waste from the cities and towns, can produce hogs more cheaply than the man who feeds high-priced grains. It takes from six to nine pounds of garbage to produce as much pork as a pound of mixed balanced grains.

The best forage crops and pastures for swine are alfalfa, red clover, dwarf essex rape, blue grass, rye, wheat, soy beans, cow peas, and sweet clover. All of the clovers are especially good.

The best grains are Indian corn, barley, rye, wheat, sorghum seed, kaffir corn, milo maize, oats, peanuts, soy beans, cow peas, and other of similar nature.

The best balancers of the ordinary grains are the milks, meat meal, packing house tankage, linseed oil meal, wheat middlings, corn oil cake meal, blood meal, peanut meal, velvet bean meal, gluten feed, together with the green, preferably leguminous and tender pastures.

To secure the greatest success in the feeding and management and marketing of swine, one must look to these essentials:

First.— Locate the business where the conditions are favorable to pork production, this usually being where there is an abundance of cheap grains and other feeds suitable for swine, and where the markets are relatively good and easily accessible. Go to those sections where hogs are making their owners money.

Second.— Select good, sound, healthy, prolific foundation stock of the right market as well as the right farm type.

Third.— Have an ideal and work toward it in your feeding and breeding operations.

Fourth.— Feed a properly balanced ration, one that will supply the essential nutrients at the right time.

Fifth.— House the animals in sanitary, well-lighted, comfortable convenient quarters.

Sixth.— Keep the animals healthy by sensible methods, use preventive measures to avoid cholera, the scourge of swine husbandry, this being done by immunization, using the anti-hog cholera serum perfected by the government, and purchaseable most everywhere.

Seventh.— Be a good manager, keeping everything and everybody "lined" up so that the whole scheme harmoniously work to a common ideal of doing the right thing, in the right way, at the right time. There are many corners to watch, as in all good businesses, hence the vigilant watchful spirit is to be assiduously cultivated.

Eighth.— To be most successful in the swine business one must like it, put his heart into it, yes, and live with it.

JOHN M. EVARD,
Professor of Animal Husbandry, Iowa State College.

SWING, David, American Presbyterian clergyman: b. Cincinnati, Ohio, 23 Aug. 1830; d. Chicago, Ill., 3 Oct. 1894. He was graduated from Miami University, Oxford, Ohio, in 1852 and was for a while principal of the classical school of that institution. He afterward studied theology and in 1866 became pastor of the Fourth Presbyterian Church in Chicago. In 1874 he was tried for heresy but was acquitted by the presbytery. He, however, withdrew from the denomination and becoming an independent minister was pastor of the Central Church in Chicago for the rest of his career. He was a pulpit orator of much power and during his long pastorate of the Central Church constantly attracted large congregations. He was an editor of *The Alliance* and published 'Club Essays' (1880); 'Truths for To-day'; 'Motives of Life' and other works. Consult Newton, J. F., 'David Swing, Poet-Preacher' (Chicago 1909; reprint, New York 1914).

SWINGLE, Walter Tennyson, American botanist and agriculturist: b. Canaan, Pa., 8 Jan. 1871. He was graduated at the Kansas State Agricultural College in 1890. He was appointed special agent of the division of vegetable physiology and pathology of the United States Department of Agriculture in 1891. He studied in Europe in 1895–96 and again in 1898; was appointed agricultural explorer of the Department of Agriculture in 1898 and since 1902 has been in charge of crop physiology and plant breeding investigations for the department. He has visited the countries of southern Europe, Asia Minor, China, Japan and the Philippines in the course of his investigations. He introduced the fig insect into California, which permitted the raising of Smyrna figs there, and had charge of the introduction of date, pistachio nut, Egyptian cotton and other useful crops into America. Author of numerous papers and reports.

SWINOMISH. See SALISHAN INDIANS.

SWINTON, John, American journalist and author; brother of W. Swinton (q.v.): b. Salton, Scotland, 12 Dec. 1830; d. Brooklyn, N. Y., 15 Dec. 1901. He came to the United States in 1845, was educated at Williston Seminary, Mass., and entered the New York Medical College, but did not graduate. In 1860–70 he was chief of the editorial staff of the New York *Times,* in 1869–74 was on the staff of the *Tribune;* and chief of the staff of the New York *Sun* until 1883. He then started *John Swinton's Paper,* a weekly labor and reform journal, which he continued to edit until 1887; later was again on the editorial staff of the *Sun.* His active work in the labor movement began in 1874, when he was a workingmen's candidate for mayor of New York, but polled only a few hundred votes; after that time he was prominent as a writer, speaker and organizer in trade union and reform movements. He published 'The New Issue, the Chinese-American Question' (1870); 'A Eulogy on Henry J. Raymond' (1870); 'John Swinton's Travels' (1880); 'An Oration on John Brown' (1881); and 'Striking for Life' (1894); a defense of the American Railway Union and the Pullman strike.

SWINTON, William, American educator: b. Salton, Scotland, 23 April 1833; d. New York, 25 Oct. 1892. He came to Canada in 1843, where he studied at Toronto and then to the United States, where he continued his studies at Amherst College. He subsequently taught at Greensboro, N. C., and in New York and during the Civil War was war correspondent of the New York *Times.* From 1869 to 1872 he was professor of English language and literature in the University of California. His writings include 'Rambles Among Words'; 'Twelve Decisive Battles of the War'; 'Campaigns of the Army of the Potomac'; 'Word Analysis'; 'Studies in English literature,' and 'Outlines of the World's History.'

SWISS FAMILY ROBINSON, The, a famous romance by J. R. Wyss, which was begun by his father and published as 'Der Sweizerische Robinson.' It was translated into French and afterward into English. It is an entertaining tale written for young people, after the style of 'Robinson Crusoe,' from which the author is supposed to have derived many of his ideas, and has been cleverly parodied by Owen Wister in 'The New Swiss Family Robinson' (1882.)

SWISS GUARDS. Swiss companies served in France from the time of Louis XI, who paid particular attention to cultivate the friendship of the cantons. In 1571 Charles IX created the charge of Colonel-General of the Swiss for Montmorency, who commanded all the Swiss in the kingdom, except the 100 guards of the king. The institution of the Swiss guards as a complete regiment dates from 1616. In 1714 it was composed of 12 companies, some of which had two captains. Louis XIV gave it five officers to each company. All the officers and men were Swiss, and the companies mounted guard before the king according to the rank of the cantons to which their captains belonged. The Swiss guards followed in order of precedence after the French guards. They enjoyed liberty of worship. According to the arrangement with the Cantons, the Swiss guards could not be obliged to serve against Germany beyond the Rhine, against Italy beyond the Alps, or against Spain beyond the

Pyrenees. This convention was often broken. The attachment of the Swiss guards to the king made them obnoxious to the people during the Revolution. They were repeatedly banished and recalled, and on and after 10 Aug. 1792, when they had to defend the Louvre against the mob, they were massacred without mercy. The Lion of Lucerne was designed by Thorwaldsen in memory of their heroism. At the Restoration, a Swiss Guard was formed to guard the person of the worthless Bourbon, but it was dispersed by the Revolution of 1830. The Vatican Palace, Rome, the residence of the popes, is guarded by a company of Swiss, who are termed the Swiss Guard. Consult Stephens, H. M., ‹History of the French Revolution› (2 vols., New York 1891) and Ternaux, ‹Histoire de la Terreur› (8 vols., Paris 1863–81).

SWISS LAKE DWELLINGS. See LAKE DWELLINGS.

SWISSHELM, Jane Grey, American reformer and author: b. Pittsburgh, Pa., 6 Sept. 1815; d. Swissdale, Pa., 22 July 1884. She was among the earliest advocates of woman's rights; an ardent opponent of slavery, and while editing the Saint Cloud (Minn.) *Visitor* had her office and press destroyed by a mob for advocating abolitionism. She was among the first to become a nurse in the Union army. Besides voluminous contributions to current periodicals, she published ‹Letters to Country Girls› (1853), and an autobiography ‹Half of a Century› (1881).

SWITCH GRASS. See GRASSES IN THE UNITED STATES.

SWITCHBACK, an inclined railway in which the progress of the train or car on the descending route is effected partly or wholly by gravity, the car first running down a steep incline and by its momentum surmounting a lesser incline, alternate ascents and descents continuing to the end of the course. Switchback railways are constructed also by curving a track alternately backward and forward along the side of a hill thus obtaining practicable grades for descent. The switchback method is popularized in the circular switchback railways, a common feature at pleasure resorts. The Mauch Chunk «Switchback» in Pennsylvania is one of the best known of these «gravity railroads.» It was formally used to carry the coal from the anthracite mines to the valley; the coal is now transported through a tunnel, and the «switchback» is reserved for the amusement of visitors. See RAILWAYS, ELEVATED.

SWITCHBOARD. See ELECTRICAL TERMS.

SWITCHMEN'S UNION OF NORTH AMERICA. See RAILWAY LABOR ORGANIZATIONS, *Lesser Organizations.*

SWITHIN, or SWITHUN, Saint, bishop of Winchester (about 852–862). He was tutor to King Egbert's son Ethelwulf, a zealous builder of churches, and of conspicuous devotion. He is credited with many miracles and when he died asked to be buried where «passers-by might tread on his grave and where the rain from the eaves might fall upon it.» When a century later his body was to be exhumed for the purpose of being deposited in the Cathedral, on the day appointed for the translation (15 July) it rained and for many days after so as to delay the ceremony. Hence, it was believed, originated the popular saying that if it rain on Saint Swithin's day it will be wet weather 40 days after it.

SWITZERLAND, Fr. La Suisse; It. La Svizzera; Ger. Die Schweiz; Lat. Helvetia: An ancient federal republic of Central Europe, extending between 45° 49′ 2″ and 47° 48′ 32″ N. latitude and 5° 57′ 26″ and 10° 29′ 40″ E. longitude. The superficial area is approximately 15,983 square miles; greatest length, 226 miles; greatest breadth, 136 miles. The country is a confederation of 19 entire and six half cantons, the whole divided into 187 administrative districts. It is bounded on the north by Baden, with the Rhine as frontier; northeast of Bavaria and Württemberg, separated from them by the Lake of Constance; east by Lichtenstein and the Tyrol, with the Rhine and the Grison Alps intervening; south by Italy, where the Alps and the Lake of Geneva form natural boundaries; and west and northwest by France, where the Jura Mountains and the River Doubs form the line of demarcation. The following table shows the cantons, their areas and population, and the areas in which they joined the confederation:

CANTONS	Area in sq. miles	Population
Zürich (1351)	666	534,250
Berne (1353)	2,659	660,640
Lucerne (1332)	579	172,500
Uri (1291)	451	22,730
Schwyz (1291)	351	59,210
Obwalden (1291)	183	17,650
Nidwalden (1291)	104	13,980
Glarus (1352)	266	33,570
Zug (1352)	92	28,940
Fribourg (1481)	644	142,690
Solothurn (1481)	305	121,240
Basel-Stadt (1501)	13	142,870
Basel-Land (1501)	163	78,550
Schaffhausen (1501)	113	47,270
Appenzell Ausser-Rhoden (1513)	93	58,670
Appenzell Inner-Rhoden (1513)	68	14,860
Saint Gall (1803)	779	315,160
Grisons (1803)	2,754	119,860
Aargau (1803)	542	236,860
Thurgau (1803)	381	140,540
Ticino (1803)	1,088	160,680
Vaud (1803)	1,244	327,870
Valais (1815)	2,026	130,750
Neuchâtel (1815)	312	134,910
Geneva (1815)	107	160,960
Total	15,983	3,877,210

Nearly all the cantons have alternative names in French and German. Thus, Lucerne is Luzern in German, while Obwalden and Nidwalden are known in French as Unterwalden-le-Haut and Unterwalden-le-Bas respectively. Zug has a French equivalent in Zoug; Solothurn in Soleure; Grisons in Graubünden in German; Neuchâtel is Neuenburg; Ticino, Tessin; Vaud and Valais are Waadt and Wallis, and Geneva, Genève or Genf.

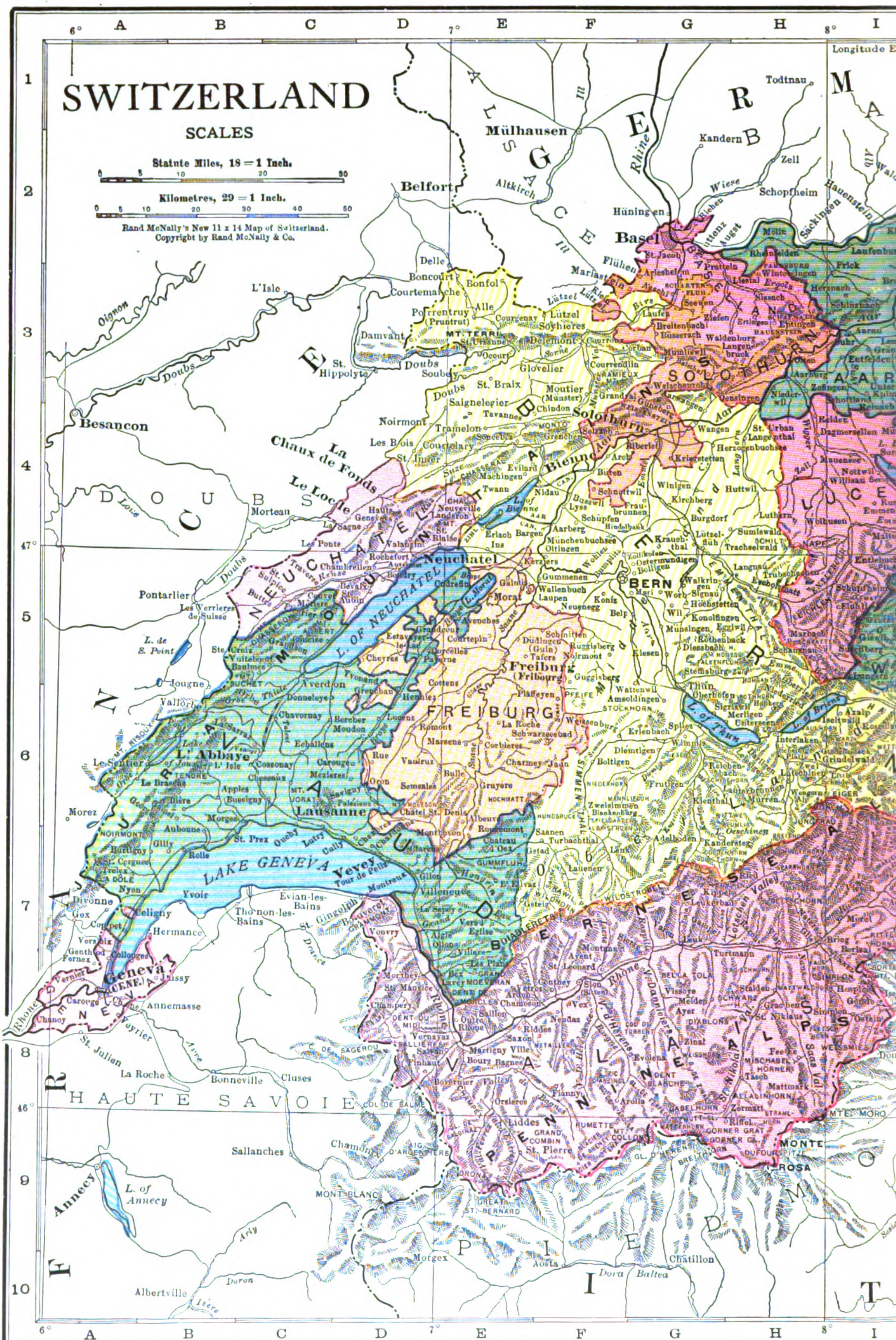
Topography.— Embracing the highest and most mountainous land on the Continent, Switzerland has aptly been styled the fortress of Europe. Its frontiers are mainly natural ones, composed of mountains, rivers and lakes. Those great mountain ranges and the large number of easily-blocked tunnels by which alone it is possible for troops to cross them may be said to make the country absolutely impregnable in the hands of a determined garrison. During the European War, Switzerland stood as a solid rock in the midst of a turbulent sea, with four nations at war on all the four sides of it. That "fortress" was the strategic key to the mid-European battle-ground; its possession would have had an enormous military value for any one of the belligerent nations. Besides the lofty ranges there are gigantic glaciers, magnificent lakes and wild, romantic valleys. Though Switzerland contains the highest ranges of the Alps and the greater portion of the Jura chain, the highest peaks of both systems belong to France. Physically the country falls into four natural divisions, the High Alps, the Outer Alps (Voralpen), the Jura, and the intervening plain which makes up the rest of the territory. The High Alps, generally called "the Alps," contain the loftiest mountain-chains, lying chiefly in the south and east. They divide the warm south from the colder north and present an imposing spectacle of towering masses of granite, mica and gneiss capped with eternal snow. An apparent labyrinth of mountains possesses a remarkable nucleus or central junction in Mount Saint Gothard (10,500 feet), which forms a kind of starting-point radiating four mountain-chains to the north, south, east and west. In like manner it unites the principal watersheds of Europe and sends its waters into four large basins — north by the Rhine to the North Sea, southwest by the Rhone to the Mediterranean, southeast by the Po to the Adriatic, and east by the Danube to the Black Sea. The other great range, the Jura (q.v.), is linked to the Alps by the small range of the Jorat. The longest and most important valleys follow the same direction as the main ranges. They are formed by the upper courses of the Rhone and the Rhine in Switzerland, besides those of the Inn and Salza, Enns and Mur, Drave and Save, farther east. The upper Rhone traces its course through the valley bounded north and south by the principal chains of the Alps, the Bernese Alps in the north, and the Pennine and Lepontine ranges in the south. The transverse valleys are shorter and more abrupt; they lie athwart the main line of the ranges and are distinguished by a regular succession of narrow gorges and level mountain glades. The largest are formed by the river Reuss in Switzerland, the Adige (Etsch) in the Tyrol, the Rhine between Coire (Chur) and Lake Constance, and the Rhone between Martigny and the Lake of Geneva. The glaciers (of which there are over 1,000) slide down in solid masses of snow and ice from the upper regions; some continue their courses for 20 or 30 miles, forcing their way through the deep channels of the huge ravines by which the mountain sides are furrowed. The Alpine passes depend on the configuration of the valley systems. Several of those passes are partially the result of human labor. Some of them communicate between valleys confined to the north or Swiss side of the Alps, and of these the most celebrated are the Grimsel and Furka passes at the head of the Rhone valley, connecting it respectively with the Haslithal or upper part of the Bernese Oberland, and the Urserenthal, or head of the valley of the Reuss, and the Gemmi or Daube Pass (7,265 feet), a remarkable piece of engineering skill, forming the only lateral communication between the Bernese Oberland and the Rhone valley. Other passes connect Switzerland with Italy, the most important being that of the Great Saint Bernard in the Pennine Chain, that of the Simplon in the Lepontine Alps, the Saint Gothard (q.v.) at the head of the valleys of Reuss and Ticino, and those of Bernardino, Splügen, Bernina, Septimer, and others leading from the Grisons southward. Altogether about 40 commerical highways pierce the Alps, besides a larger number of natural passes unprovided with roads. Of the great pass-roads connecting Italy through Switzerland with southern Germany the most important in Roman times and in the Middle Ages was the Septimer Pass (7,580 feet), connecting the head of the Val Bregaglia with the Rhine valley above Chur by way of the Oberhalbstein and the Albula. The Saint Gothard was not known to the Romans, but was frequented by pilgrims in the 13th century. The Simplon pass (6,600 feet) was a paved Roman road; the railway tunnel which runs under it was opened in 1906. The Great Saint Bernard pass (8,110 feet) connecting Switzerland with Italy starts on the Swiss side at Martigny in the valley of the Drance, and ends at Aosta in the Dora Baltea valley. The famous hospice of Saint Bernard is mentioned in documents of the 10th century.

The avalanches of Switzerland are famous for their destructive propensity, but on their record, year by year, they do not cause any appalling loss of life or property. The mighty forces of nature, in storms at sea, inundations and cyclones, cause probably a much greater proportionate loss of life and property than do avalanches. Though they fall all the year round in Switzerland, spring is the great time for avalanches. During that period some of them descend with remarkable regularity in particular places and at recognized spots. The snow piled up during the winter on the grass slopes below the (summer) snow-line, gradually loses its cohesion as the spring melting advances and glides down to its appointed place according to the trend of the ground. In places where huge masses of snow are collected above steep declivities terminating in narrow outlets the avalanches descend with terrific roar and pressure against the lines of defence — the forests. For this reason the forest laws of Switzerland are very strict. Everything is done to preserve the natural rampart afforded by a mass of pines, and no one is allowed to fell a tree on his own ground with government consent. Where avalanches fall regularly every year, stone galleries are built or tunnels are mined out of the solid rock to protect roads. Many protective devices are employed to arrest the torrents of ice, snow and slush so that the danger from them has largely diminished. The so-called *Staub-Lawine* or Dust-Snow avalanche is the most dangerous on account of its suddenness, and the most difficult to provide against. This is a collection of loose, freshly-fallen snow which has been caught up in one of those sectional tornados that spring up on the mountain slopes, and is driven down on the wings of the wind to the valley below. The *Schlag-Lawine* or Stroke-Avalanche is the usual spring variety, which pour down the slopes like a swiftly-flowing river. This is the type that can be more successfully regulated. It has a secondary form in the *Grund-Lawine* or ground avalanche, which carries earth and rubbish with it and performs a beneficial task in bringing down soil from the heights to the plains. Whereas the avalanche is snow in quick movement toward the valleys, the glacier is snow (pressed into ice) in slow movement. See GLACIAL PERIOD; GLACIER.

Rivers and Lakes.— Owing to its mountainous nature Switzerland is naturally a land belonging to many river systems, though none of the rivers acquires such a size within its limits as to become of much navigable importance. Its position as the centre of the principal watersheds of Europe has been referred to. Great rivers take their origin in Switzerland and attain their chief development in other countries. Both the Rhine and the Rhone rise here, as well as the Po and the Danube. The first three spring from the Saint Gothard mountain mass, but the Rhine is formed by the junction of three distinct head-streams, the Vorder, Mittel and Hinter-Rhine. It flows north into the Lake of Constance, and thence west to Schauffhausen, where it forms the celebrated falls of that name, the largest in Europe in volume. It is navigable for vessels at Coire in the canton of Grisons for vessels of 150 tons, but its navigation properly begins below the falls. Its principal affluent in Switzerland is the Aar, which, after traversing the Lakes of Brienz and Thun, winds across the Swiss plateau to join the main stream about midway between Lake Constance and Basel. The Rhone, said to be the most rapid of the larger rivers of the world, rises in the Rhone glacier (Valais), flows northwest into the Lake of Geneva, issues thence at the town of Geneva under the name of the Arve, and quits Swiss territory about 10 miles below. The waters which the Po receives from Switzerland are carried to it by the Ticino, and thereby to the eastern bay of the Mediterranean; those which the Danube receives are carried to it by the Inn and taken thence on to the Black Sea. The lakes and mountains form a more important hydrographical feature than the rivers. The former are remarkable for their number, size, depth and the grandeur of their scenery. The largest lake, that of Geneva (also known as Lake Leman), has an area of about 220 square miles; Lake Constance, in the northeast, has 208 square miles. Both of these, as well as Maggiore on the south side of the Alps, belong partly to other countries; but within the limits of Switzerland, and not far from its centre, are Lake Neuchâtel (93 square miles), with Morat and Bienne in its vicinity. Thun with its feeder Brienz, Lucerne or Vierwaldstättersee, Sempach, Baldegg, Zug, Zürich and Wallenstättersee. All these internal lakes belong to the basin of the Rhine. The greatest depth of Lake Geneva is 1,015 feet, placing the bottom at about 200 feet above sea-level; the bottoms of the lakes on the southern side of the Alps are below the level of the sea. Rapid mountain torrents feed nearly all the Swiss lakes, entering their upper ends thickly charged with sediment, which is deposited when the rivers enter the lake, to leave it at the lower end as clear streams. Thus the lakes filter and regulate the rivers, thereby protecting nearly all the lower valleys of the country from serious floods. The Aar formerly overflowed its banks, but this has been remedied by the construction of a canal to divert the river into the Lake of Bienne, by which the lower course of the stream is regulated.

Geology and Minerals.— The most remarkable feature in the complicated geological structure of Switzerland and of the Alps generally is the extent to which the flanks of the Alps have been folded, contorted and inverted by the tremendous forces that led to the elevation of these mountains. A typical example is presented by the Saint Gothard, where the central core crops out at the summit of the ridge, and the strata on each side of it, north and south, dip inwards toward the base, so that when seen in section they would present the appearance of the ribs of a fan radiating from a single point. All the loftiest Alpine ranges have a nucleus of granite, on which gneiss and mica-slate recline generally at a high angle. On the west of the plateau the Jura give their name (Jurassic) to the rocks of which they are composed; the mountains on the east are mainly formed of gneiss and mica-schist with various slates in places, especially in the Grisons. The Swiss plateau, stretching from southwest to northeast between the Geneva and Constance lakes, may be described as an area of Tertiary (principally Miocene) deposits separating the two mountain regions composed chiefly of rocks of more ancient date. Switzerland is not rich in minerals; iron ore is found and worked at various places. Asphalt, sulphur and salt occur in certain districts, and formerly argentiferous copper and lead ore were extracted in the canton of Grisons. A profitable source of national wealth is provided by an abundance of mineral springs. Thermal and medicinal baths are dotted all over the country. Baden (q.v.), the chief of the bath centres, enjoys a most salubrious climate and its hot springs have been celebrated since Roman times. Other celebrated health resorts are those of Schinznach in Aargau, Pfeffers in Saint Gall, Leuk or Loueche and Saxon in Valais, Saint Moritz in the beautiful Engadine, with Bernhardin, Fideris and Schuls-Tarasp, Alveneu and Serneus; Blumenstein, Weissenburg and others in canton Berne; Weissbad near Appenzell, Stachelberg in Glarus, Seewen in Schwyz, and Schwendi-Kaltbad in Unterwalden. Altogether there are close on 400 health resorts in Switzerland, many containing luxurious hotels, Kurhäuser, casinos, clubs and theatres, with numerous attractions for devotees of winter sports and tennis lawns. Native industry and initiative have so successfully exploited the gifts of nature that Switzerland has become the "playground of Europe" — if not of the world.

Climate.— The crest of the Alps forms a huge dividing-wall between the polar and the equatorial winds, the latter of which frequently deposit their moisture in the form of rainfall on the southern side of the range. The best-known wind is the *Föhn*, a warm, moist south wind that blows with great velocity in eastern


SWITZERLAND
SCALES
Statute Miles, 18 = 1 Inch.
0 5 10 20 30
Kilometres, 29 = 1 Inch.
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Rand McNally's New 11 x 14 Map of Switzerland.
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6° A B C D 7° E F G H 8° I
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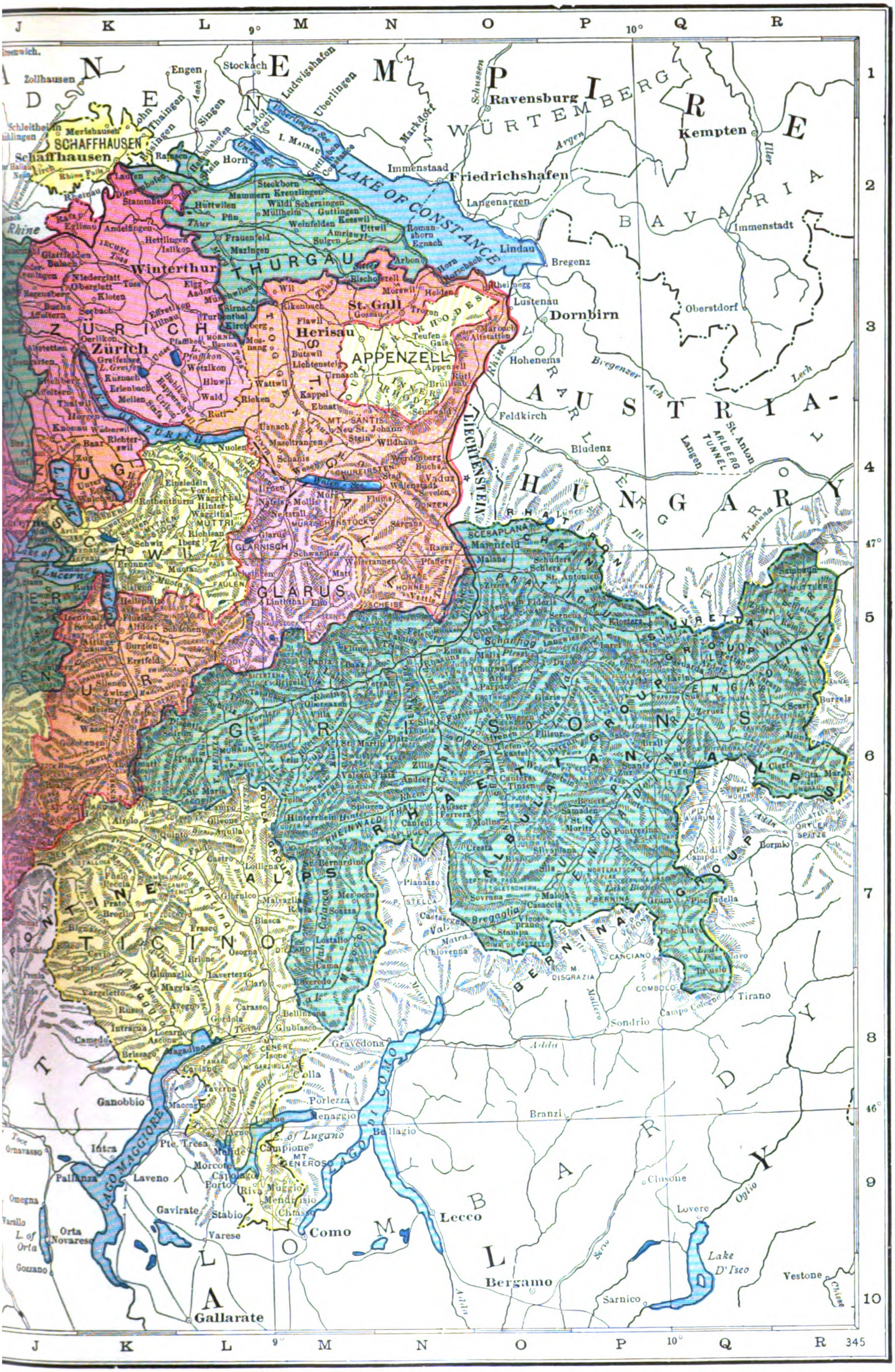
1 2 3 4 5 6 7 8 9 10
47°
46°
GERMANY
FRANCE
ITALY
ALSACE
DOUBS
HAUTE SAVOIE
PIEDMONT
Mülhausen
Belfort
Altkirch
Basel
Hüningen
Kandern
Zell
Schopfheim
Todtnau
Säckingen
Laufenburg
Rhine
Ill
Wiese
Delle
Boncourt
Bonfol
Courtemaiche
Porrentruy (Pruntrut)
Alle
Damvant
MT. TERRI
St. Ursanne
Delémont
Soyhières
Lützel
Laufen
L'Isle
Oignon
Doubs
St. Hippolyte
Besançon
Soubey
St. Braix
Saignelegier
Moutier (Münster)
Noirmont
Tramelon
Tavannes
Les Bois
Courtelary
St. Imier
La Chaux de Fonds
Le Locle
Morteau
Loue
Pontarlier
Les Verrières de Suisse
L. de S. Point
Jougne
Vallorbe
Le Sentier
L. Abbaye
La Brassus
Morez
Divonne
Gex
Nyon
Rolle
Morges
Lausanne
Vevey
Montreux
LAKE GENEVA
Yvoir
Évian-les-Bains
Thonon-les-Bains
Hermance
Geneva
Carouge
Chancy
Annemasse
St. Julien
La Roche
Bonneville
Cluses
Sallanches
Chamonix
MONT BLANC
GREAT ST. BERNARD
Annecy
L. of Annecy
Albertville
Isère
Arly
Doron
Morgex
Aosta
Dora Baltea
Châtillon
Sesia
Neuchatel
L. OF NEUCHATEL
NEUCHATEL
Yverdon
Grandson
Estavayer
Payerne
Avenches
Morat
L. of Morat
Freiburg (Fribourg)
FREIBURG
Romont
Bulle
Gruyère
Châtel St. Denis
Bienne
L. of Bienne
Solothurn
SOLOTHURN
BASEL LAND
Liestal
Waldenburg
Olten
Aarburg
Zofingen
Burgdorf
BERN
Thun
L. of Thun
L. of Brienz
Interlaken
Spiez
Frutigen
Adelboden
Kandersteg
Saanen
Château d'Oex
VAUD
Aigle
Bex
St. Maurice
Monthey
Martigny
Sion
Sierre
Brieg
Zermatt
MONTE ROSA
Saas
St. Niklaus
Visp
PENNINE ALPS
BERNESE ALPS
Rhone
Lötschen Valley
Leuk
Turtmann
Evolena
Liddes
St. Pierre
GRAND COMBIN
MT. COLLON
MATTERHORN
DENT BLANCHE
WEISSHORN
SIMPLON
MTE. MORO
Luthern
Willisau
Entlebuch
Sursee
Aarau



GERMAN EMPIRE
WÜRTEMBERG
BAVARIA
AUSTRIA-HUNGARY
LAKE OF CONSTANCE
SCHAFFHAUSEN
Schaffhausen
THURGAU
ZÜRICH
Zürich
Winterthur
ST. GALL
St. Gall
Herisau
APPENZELL
GLARUS
ZUG
SCHWYZ
URI
GRISONS
TICINO
LIECHTENSTEIN
VORARLBERG
RHAETIAN ALPS
LEPONTINE ALPS
ALBULA GROUP
SILVRETTA GROUP
BERNINA GROUP
ENGADINE
Ravensburg
Kempten
Friedrichshafen
Lindau
Bregenz
Dornbirn
Feldkirch
Bludenz
Immenstadt
Oberstdorf
Immenstaad
Langenargen
ARLBERG TUNNEL
St. Anton
Vaduz
Stockach
Singen
Engen
Uberlingen
Lugano
L. of Lugano
LAGO MAGGIORE
LAGO DI COMO
Lake D'Iseo
Como
Lecco
Bergamo
Gallarate
Varese
Bellinzona
Locarno
Chiavenna
Sondrio
Tirano
Bormio
Pallanza
Intra
Laveno
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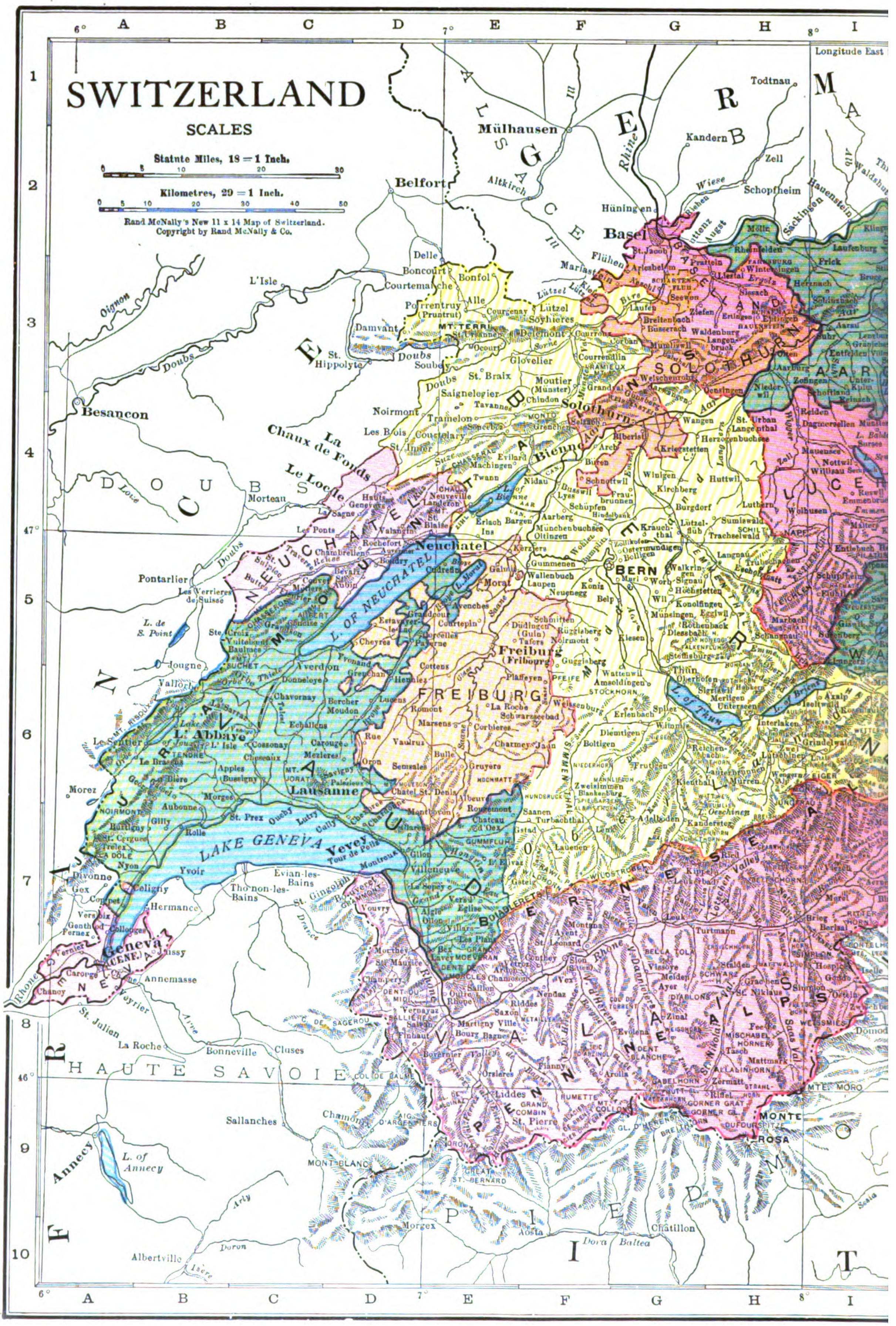
SWITZERLAND
SCALES
Statute Miles, 18 = 1 Inch.
Kilometres, 29 = 1 Inch.
Rand McNally's New 11 x 14 Map of Switzerland.
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Longitude East
ALSACE
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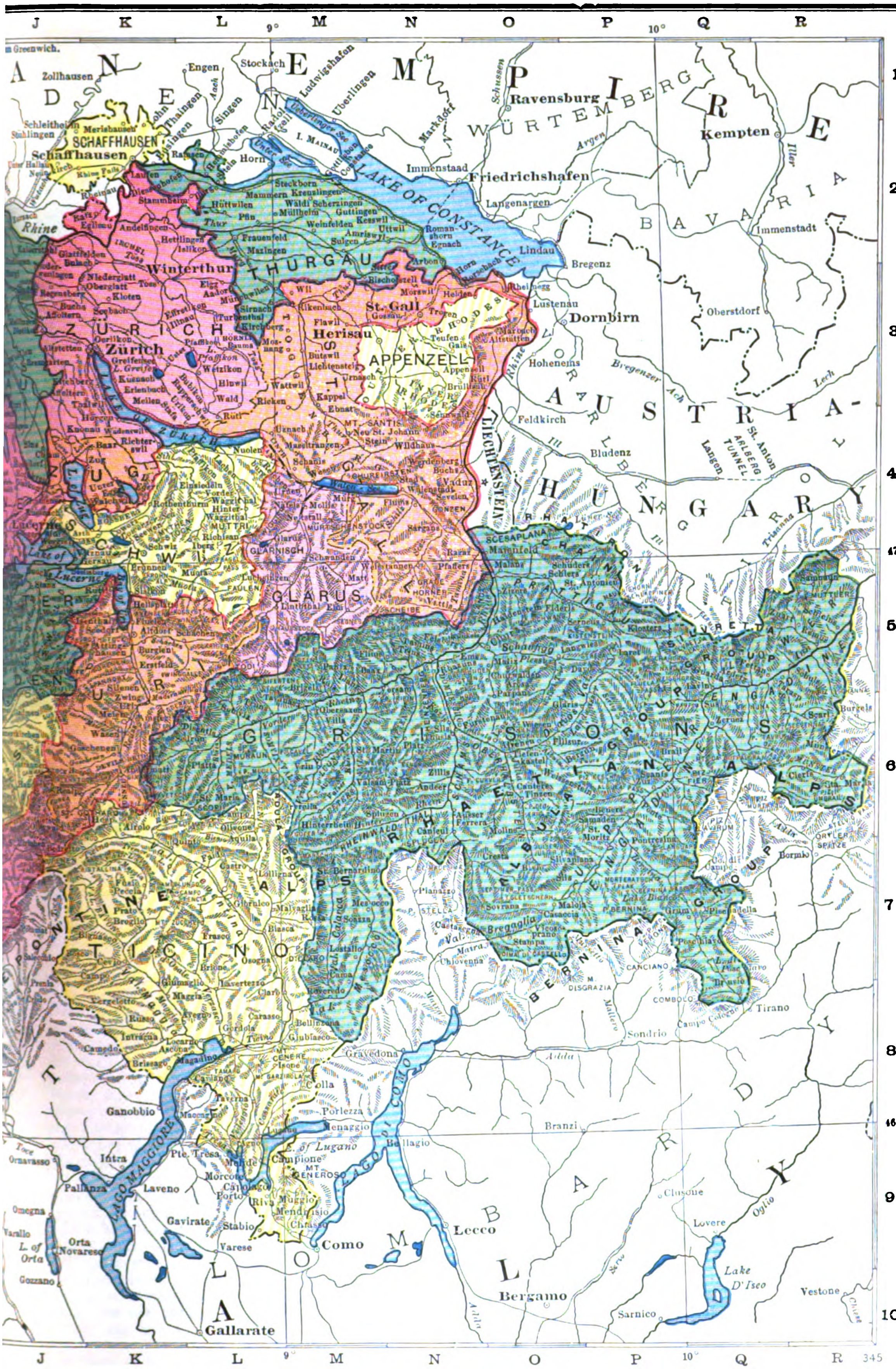
FRANCE
DOUBS
HAUTE SAVOIE
ITALY
Mülhausen
Belfort
Besancon
Basel
Solothurn
Bienne
Neuchatel
Bern
Freiburg
Lausanne
Vevey
Geneva
LAKE GENEVA
L. of NEUCHATEL
L. of Thun
L. of Brienz
L. of Annecy
Annecy
Pontarlier
La Chaux de Fonds
Le Locle
Yverdon
Thun
Interlaken
Sion
Zermatt
MONTE ROSA
MONT BLANC
GREAT ST. BERNARD
Aosta
Chamonix
Sallanches
Bonneville
Albertville
PENNINE ALPS
BERNESE ALPS
FREIBURG
SOLOTHURN
NEUCHATEL
VAUD
VALAIS
BERN
AARGAU
LUCERNE
GENEVA


J K L M N O P Q R
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GERMAN EMPIRE
WÜRTEMBERG
BAVARIA
AUSTRIA-HUNGARY
VORARLBERG
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LOMBARDY
LIECHTENSTEIN
SCHAFFHAUSEN
Schaffhausen
THURGAU
ZÜRICH
Zürich
Winterthur
ST. GALL
St. Gall
Herisau
APPENZELL
Appenzell
ZUG
SCHWYZ
GLARUS
URI
GRISONS
TICINO
LAKE OF CONSTANCE
LAKE OF ZÜRICH
Walen See
RHAETIAN ALPS
LEPONTINE ALPS
ALBULA GROUP
SILVRETTA GROUP
ENGADINE GROUP
BERNINA GROUP
Ravensburg
Kempten
Friedrichshafen
Lindau
Bregenz
Dornbirn
Feldkirch
Bludenz
Immenstadt
Oberstdorf
ARLBERG TUNNEL
Chiavenna
Sondrio
Tirano
Bormio
Lecco
Como
Bergamo
Gallarate
Lake Maggiore
L. of Lugano
L. di Como
Lake D'Iseo
Intra
Pallanza
Laveno
Varese
Stockach
Ueberlingen
Singen
Engen
Rhine
Adda
Oglio
345

Switzerland and the upper valleys of the Rhine, Reuss, Rhone and Linth, and is frequently followed by heavy rain. On its approach the thermometer rises and the barometer falls rapidly; presently a fierce storm breaks out. The *Föhn* is calculated to blow for 17 days in spring, five days in summer and 16 days in autumn. The cold north-northeast wind, known by the French name of *bise*, blows in the direction of Geneva between the Bernese Oberland the Jura, but is little noticeable in summer. Various local winds prevail at the higher levels and are of great importance to invalids, e.g., the uniform morning wind, blowing down-hill, in regular alternation with the evening wind, blowing up-hill. The higher inhabited regions of Switzerland may be divided into three zones. The lowest of these, the hill region, between the elevations of 1,300 and 2,600 feet above sea-level, embraces the banks of the lakes in northeast and central Switzerland and the adjacent mountain slopes. Great heat often prevails here in summer, though a pleasant relief is afforded by the lake baths. Lake Constance is the warmest of the inland waters, with a temperature of 68° to 75° F. The second, or mountain region, extends from 2,600 to 3,900 feet, a district of numerous towns and villages. The third, or Alpine region (3,900 to 6,550 feet), presents a much lower temperature and dry, clear weather suitable for certain classes of invalids suffering from lung disease. At Sils-Maria, in the upper part of the Engadine valley, the mean January temperature is 17½° F.; mean July, 53°, and the mean of the whole year 34°. In general the valleys have a severer winter than mountain peaks of equal elevation, as the colder and, therefore, heavier air steadily sinks down to the bottom of the hollows. At places north of the Alps, such as Zürich and Berne, the normal winter temperature is about 30° F., the summer temperature from 50° to 64° or upwards; at Geneva the corresponding temperatures are as high as 33° and 66°. Some of the high-lying valleys, especially those that are open to the east and closed to the west, are facetiously said to have nine months' winter and three months' cold.

Flora and Fauna.— The differences of elevation affect equally the climate and the natural productions of the soil, hence few countries in Europe, even of larger extent, can boast of a more varied vegetation than Switzerland. The flora of the Alps is one of peculiar interest. Like all great mountain ranges the Alps harbor a considerable number of plants found nowhere else, and of those which are found elsewhere the majority do not reappear in the plains and valleys below, but in distant mountains or in the Arctic regions. Out of upwards of 800 species belonging to the Alps, but not to the adjoining lowlands, nearly one-fourth are absolutely restricted to these mountains, and nearly a fifth are found also in the Arctic regions, these being what are hence known as Arctic-Alpine plants. As the elevation ascends there is a gradual change in the aspect of the vegetation, which has been divided into seven regions. In comparison with adjacent countries, Switzerland possesses few forests, and these have little effect in increasing the atmospheric moisture or in moderating the extremes of temperature. In the valleys at the base of the mountains chestnut and walnut grow freely even on the north side, while in the valleys opening toward the Mediterranean lies a zone occupied by these trees while still at a considerable elevation. Higher up is the zone of the beech, maple and other ordinary foliage trees reaching to about 4,000 feet, and then the zone of firs and pines rising about 1,000 feet higher. This region is followed by one of Alpine shrubs, among which rhododendrons («Alpine roses»), heaths and whortleberries are conspicuous, along with larches and two species of pine, the dwarf-pine and the cembra-pine, remarkable for its edible seeds and peculiar to this zone. The shrubs cease to grow at about the height of 7,000 feet, but the Alpine plants that cover the pastures intermingled with the shrubs ascend to the snow line, and even beyond in places too steep for snow to lie. Heer collected about 100 different species of flowering plants above the snow limits on the peaks of the Grisons at about 8,500 feet; 24 species have been observed on the Grands Mulets on Mont Blanc at a height of from 9,800 to 10,600 feet; and the sides of the Pizzo Centrale on the Saint Gothard have been known in August to spread to a considerable distance the fragrance of the flowers which covered them in patches. The celebrated edelweiss, which all Alpine tourists eagerly collect, is the most retiring of these snow region plants. Of utility plants the characteristic product of the plain and lower regions is the vine, which grows up to about 1,800 feet above sea-level. The hilly or lower mountain region up to 4,000 feet produces good crops of barley and oats and excellent pastures. Above this, in the Sub-Alpine region, up to 5,500 feet, no regular crops are grown; in the upper Alpine region the vegetation becomes more stunted and the variation of the seasons is lost. Beyond lies perpetual snow. Many parts even of the lower parts of the country are stony and sterile, but no spot that can be turned to good account is left unoccupied. Though chiefly an agricultural country, Switzerland cannot grow enough crops to support its population, so that the majority of the foodstuffs have to be imported. The productive land is cut up among some 300,000 peasant proprietors who raise, besides the crops already mentioned, wheat, spelt, rye, potatoes and tobacco, and manufacture cheese, condensed milk and wine. Nearly 30 per cent of the entire area is unproductive and about 36 per cent is under grass and meadows. Considerable quantities of fruits are grown. Among domestic animals the first place belongs to the horned cattle. At the last census there were in the country 136,613 horses, 1,615,645 cattle, 171,635 sheep, 550,000 pigs and 358,000 goats. In the summer the cattle are fed on the numerous mountain pastures or «alps,» but of their winter fodder a large proportion has to be imported. In several cantons bee-keeping and silkworm culture are carried on. Among the wild animals are bears, wolves, chamois, goats, boars, stags, badgers, foxes, hares, otters, squirrels; birds of prey of large dimensions; the snipe, heathcock, cuckoo, blackbird and woodpecker. The lakes and rivers produce a varied abundance of fish.

People.— The Swiss are a mixed people as to race and language. The bulk of the population is of Teutonic race, but the Latin race (partly French, partly Italian) compose nearly three-sevenths of the whole. The Swiss Teutons belong to the Alemannic stock and still speak a difficult Alemannic dialect usually called Swiss German or simply Swiss. They occupy the whole of the upper Rhine valley, as far as its extreme western angle at Basel, consequently the whole of the Helvetian highlands lying north of the Central Alps, besides the upper Rhone valley down to Sion or Sitten, under the Bernese Alps. The rest of the upper Rhone valley and the western slopes of the Jura are French, comprising the cantons of Valais, Vaud, Geneva and Neuchâtel. The Italian portion is made up of those parts which belong to the basin of the Po — the whole of the canton of Ticino and the valley of Poschiavo in the Grisons. Along the head streams of the Rhine, in the valleys of the Grisons, and in the region between these rivers and the banks of the upper Inn, and even still farther eastwards, in some Tyrolese valleys beyond the Swiss frontier, are scattered the Rumonsh-speaking people, whose language at first sight seems like a sort of connecting link between German and Italian. These are the interesting Rhæto-Romance tribes, which had long failed to receive the attention of the scientific world. Critical research has since established that Rumonsh is an entirely independent Neo-Latin tongue, standing on the same level as Spanish, Portuguese, Italian, Langue d'Oc, Moldo-Wallachian (Rumanian) and Langue d'Oïl. Rumonsh has two main dialects — the Overland dialect or Rumonsh proper, divided into two sub-dialects, the Sur-Selvian and Sub-Selvian, and the Engadine or Ladin dialect (see RHÆTIA). Yielding to the pressure of the vigorous Teutonic tribes, the Rhæto-Romance races became at last confined to the solitary upland valleys, where they still continue to eke out a laborious existence. Their speech is also steadily yielding to encroachments and is gradually being supplanted either by German or Italian. As the Swiss races differ in origin and language, so also do their temperamental characteristics vary. The French Swiss is active and vivacious; the Italian Swiss, fiery and irritable; the German Swiss, calm and thoughtful. Yet with all their racial and spiritual divergences, a fervent patriotism is common to all of the Swiss people. Independence and liberty are the keynotes of their existence. There is no desire among the German, French or Italian Swiss to be united with their neighbors of corresponding nationalities. It has been said that the Swiss as a people often suffer in the judgment of tourists by failure to live up to their reputation as a «mountain people»— to a glorious «Alpine» character. In truth, however, the idea that dwelling in a mountain region has an ennobling influence on the human character is mostly fallacious. The Swiss are expected by the traveler to carry themselves in all things with the pride and dignity of people who are born and bred in the original home of European liberty. But civilizations and traditions of human freedom have always begun on the plains — by seashore and river bank. If all the facts are taken into account, it is rather a handicap than an advantage to a race to inhabit a mountain country, for in the earlier stages of civilization the mountain fastnesses have imposed upon them the duty of sheltering alike fleeing patriots and criminal fugitives from justice. In later stages, again, mountains interfere greatly with development of the machinery of civilization. It has been facetiously pointed out that mountain air sharpens the appetite more than the wits, and there are some diseases attacking particularly the brain which are almost peculiar to mountain districts. The one favorable national circumstance of the Swiss is that their central position in regard to the great plains of Europe has put them in the track of all the chief currents of civilization. What they have achieved in spite of the handicap of their mountains is one of the marvelous stories of the human race. To these massive barriers they owe in the main their sense of national unity.

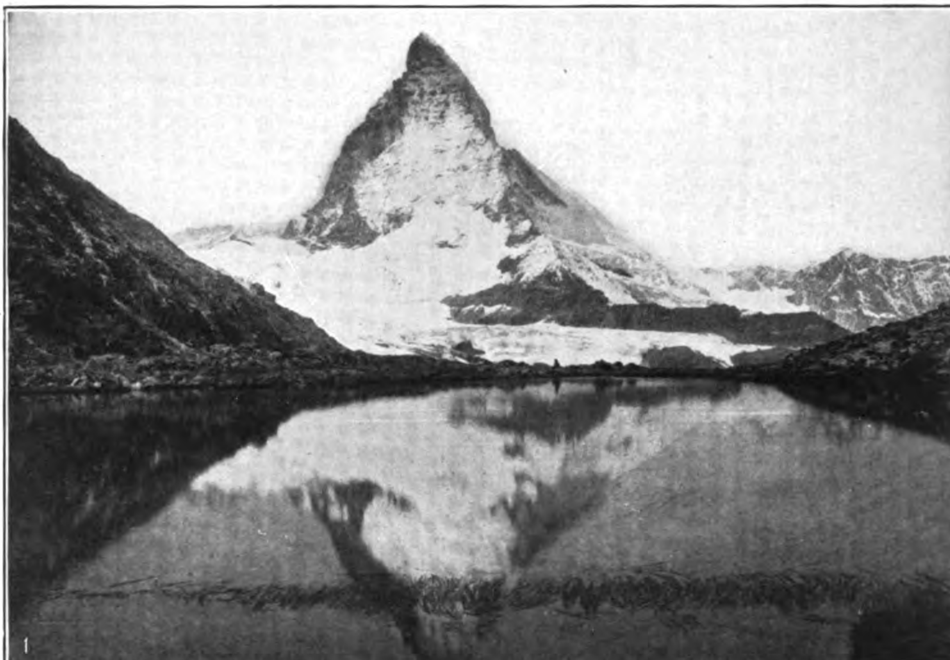
Industries; Chief Towns.— The Swiss depend for their support on various branches of industry, to which much attention has been given of late years. There are now large silk and cotton factories, while the watch-making industry established in Geneva since the end of the 16th century has long been famous. Other industries are: Embroidery, musical boxes, chocolate (Suchard, Cailler, etc.), shoemaking, straw plaiting, wood carving, aniline dyes, pottery and aluminum. Asphalt is worked by an English company at Val de Travers and Neuchâtel. In the lowlands the chief occupations are agriculture, horticulture and wine growing. In the highlands almost the sole industry is the rearing of livestock. The principal imports are cereals, fruits, vegetables, colonial produce, animal food substances, iron and mineral products. Being an inland country, Switzerland has direct commercial intercourse only with the surrounding states; but the trade with other countries, especially Great Britain and the United States, is very important. A source of enormous profit is the catering for the thousands of tourists who invade the country. Switzerland is noted for its hotels, and it is no exaggeration to say that the Swiss are the most expert artists in hotel-keeping. The large modern establishments at Geneva, Vevey, Zürich, Lucerne, Interlaken, etc., are models of comfort and organization; the smaller hotels are often equally well conducted, and indeed a really bad inn is rarely met with in French or German Switzerland. In normal times the prices are extraordinarily moderate. A flourishing occupation is that of the professional guide, who is indispensable for expeditions among the higher mountains, especially on those which involve the passage of glaciers. As a class, these guides are intelligent and respectable men, well versed in their duties and thoroughly acquainted with the people and resources of the country. The town life of the Swiss is strongly affected by the hotel life of the tourists. The inhabitants are generally well educated and proficient in languages. Offering asylum as it does to political and social rebels of all countries, Switzerland is a kind of international clearing house for thought and theory. For many years it has been the free and open laboratory in which the schemes of anarchists, Bolsheviki, Nihilists, Young Egyptian and Young Turkey exiles were hatched. During the European War the country was the mecca of diplomats, conspirators and high-born refugees. The Gallic, the Teu-

SWITZERLAND

1 Mt. Blanc

2 St. Gotthard Pass and Bridge

SWITZERLAND



1 The Matterhorn and Riffelsee

2 Lake Lucerne (Vierwaldstattersee)

tonic and the Slav new thought of the day are all understood and discussed in Switzerland, and the Swiss book stores are the most cosmopolitan and representative in the world. There are few important towns, the chief being Zurich, Basel, Geneva, Bern (the federal capital), Lausanne, Saint Gallen, Chaux-de-Fonds, Lucerne, Biel Winterthur and Neuchâtel. Geneva, the home of the Red Cross, was designated the capital of the League of Nations by the Allied Peace Conference of 1919.

Communications.— The state railroads of Switzerland have a length of 3,670 miles, while there are 32 miles of foreign railways within the confederation. Owing to the heavy capital charges ($465,000,000) the state railways do not show a profit. In the last normal year (1913) they carried 91,546,639 passengers. The cars on most of the lines follow the American plan. On the waterways and lakes 22 companies operate 170 steamers and barges. The organization of the post office is highly efficient. Tourists' baggage may be transported very cheaply by parcel post; delivery is prompt and reliable. There are over 2,000 post offices; 2,135 miles of telegraph lines and 2,390 telegraph offices. Every year there are constructed new funicular railroads and tramways leading up the mountain sides; these produce a good profit — over 3 per cent, and are usually privately owned. In June, 1918, the Swiss National Council adopted a project of Federal subvention of a port on the Rhine at Basel, which will open that river to commercial traffic between Germany and Switzerland. To counteract the possibility of drawing the republic within the sphere of German economic influence, an alternative was proposed, by which Switzerland could be placed into direct communication with the Mediterranean via the Rhone. This river could be made navigable for the 20 miles between Geneva and Lyons by the construction of a lock at Genissiat, just below Geneva. By this route Switzerland could obtain all the products necessary for its existence. In April 1919 it was announced that Switzerland had acquired 28 vessels, of 105,000 tons total tonnage, to be attached to the port of Cette on the French coast (Gulf of Lyons), with which a special line will connect with the Swiss railways. The installation of a central warehouse is projected at the Etang de Thau.

Religion and Education.— There is complete religious liberty in Switzerland. According to the last census there were 2,107,814 Protestants, 1,593,538 Roman Catholics and 18,465 Jews. The order of the Jesuits is not allowed within the confederation. In 12 of the cantons the Protestants form the majority; the Catholics in 10. The latter have the larger number of clerics, some 6,000, under five bishoprics, those of Basel and Lugano, Chur, Saint Gallen, Lausanne and Geneva. The Protestant Church is Calvinistic in doctrine and Presbyterian in form; it is under the supervision of the cantonal magistrates. No one is called on to pay taxes specially appropriated for the support of a creed which he does not adhere to. The foundation of religious orders or new convents are prohibited.

The Swiss educational system is both generous and practical, with compulsory attendance (at nine years) enforced and free instruction, books and materials provided. The elementary school classes are mixed and contain up to 45 children. The curriculum assures to boys and girls a general elementary education including a knowledge of French, while considerable time is also devoted to physical exercise, carpentry, needlework and cookery. After a four years' course the scholars enter the secondary schools, where they remain till 15. After a five years' advanced course in the secondary school the scholars have the option of ultimately entering the gymnasium or the industrial and commercial schools. Up to the age of 15 instruction is free; after that the annual fees amount to 60 francs ($12). There are great universities in the chief cities, which are much frequented by foreign pupils. The Swiss technical schools are second to none in the world; they teach everything from waiting at table to watch-making and science. In mountain villages the schools are kept open only during the long Alpine winter. All through the summer the boys work in the fields, while the masters and teachers attend to their own farms. From the primary schools to the universities there are splendid facilities for learning. In the 4,690 primary schools there are about 530,000 pupils annually under 12,023 teachers. The cost of these institutions is little over $10,000,000 a year. In the 642 higher schools there are about 60,000 pupils annually under 2,000 teachers. The cost of these is about $1,500,000 a year. Besides these there are schools of agriculture, dairying, commerce, etc., while continuation commercial schools give further instruction to some 10,000 pupils yearly, who attend vacation and evening classes. In the seven universities, Basel, Zürich, Bern, Geneva, Lausanne, Fribourg and Neuchâtel, there is an average of 9,000 students a year, of whom fully a third are foreigners. An average of 15,000 children a year are treated in the correctional schools, and some 1,300 in 28 schools for the feeble-minded. There are 14 special schools for deaf-mutes, with an average of 700 pupils a year. Special attention is paid in all Swiss educational institutions to gymnastics and physical culture.

Government.—As already stated, Switzerland is a confederation of 19 entire and six half cantons, which have been united for federal purposes since 1848. The present constitution, which dates from 29 May 1874, vests supreme legislative and executive authority in two chambers — (1) a State Council (Ständerath) of 44 members, chosen two for each canton and one for each half-canton for three years; and (2) a National Council (Nationalrath) of 167 delegates of the Swiss people, chosen also for three years by direct manhood suffrage, one deputy for every 20,000 of the population. Among the various forms of government developed in Europe that of a federal republic has been achieved by Switzerland alone. That country may claim to possess the only truly democratic government in the world. The Swiss have produced great results with small resources; they have shown what the plain man can do in the way of government without the help of a ruling class, of gentlemen of leisure, of millionaires or of professional politicians. An ideal democratic constitution should make it impossible for political representatives to impose on the country laws which the people do not want. It should also be difficult, if not impossible, for a small majority to impose constitutional changes to which nearly one-half of the electors are opposed. Yet these obvious requirements are conspicuously absent in democratic countries, for it is often uncertain how far laws, which are easily carried through a parliament or congress, are really wanted by the people, and whether, if put to the popular vote, they would have even a bare majority in their favor. The expression of the will of the people as an aim of government is altogether lost sight of and party necessities become the sole motives of political action. Another requirement of democratic government is that the political machine should work as smoothly as possible, and for this end care should be taken so as to constitute the legislative and executive bodies as to avoid as far as possible the political crises consequent upon sudden changes of government and to minimize the turmoil and excitement produced by elections. The Swiss have solved these difficult problems with ingenuity and originality; they have evolved a political machine in which the frank and sure expression of the popular will and the smooth working and stability of government are obtained to far greater extent than in any other country.

Though the cantons are united together as a confederation or "Eidgenossenschaft" for mutual defense, each retains its individual independence and governs itself according to the constitution best suited to its own requirements. In these various constitutions there are gradations from the fullest democracy to the purest representative forms; but pure non-representative democracies have been adopted in the smaller cantons only, such forms of government being in fact impracticable except among small populations. The united chambers form the Federal Assembly, to which is confided the supreme government. The executive authority is deputed to a Federal Council (Bundesrath) of seven members, elected for three years by the Assembly, the president and vice-president of which are elected annually, and are the first magistrates of the republic. The Council sits at Bern, which is the headquarters of the federal administration. Though ranking only fourth in point of population, Bern owes its status as capital (since 1848) partly to its central position in the Swiss tableland and partly to the historical importance of the canton, which is itself a result of that position. The principles of the referendum and of the initiative are in force. By the former, if a petition is presented by 30,000 citizens for the alteration or revocation of a measure passed by the legislature, or eight cantons demand it, the law in question must be referred to the direct vote of the nation. The latter signifies the right of any 50,000 citizens to demand a direct popular vote on any constitutional question. The federal government alone can contract treaties or declare war; it also controls the army, postal system, finance and customs. The cantonal authorities have jurisdiction over civil and criminal law, justice, police, public works and schools. The president is elected annually and receives a salary of $2,700; he is usually succeeded by the vice-president, whose salary is $2,400, the same remuneration paid to the other five members of the Bundesrath. These seven officials act as ministers: (1) Foreign Affairs; (2) Interior; (3) Justice; (4) Military; (5) Finance; (6) Agriculture and Industry; (7) Posts and Railroads. The 44 members of the State Council receive about four dollars per day, more or less, as stipulated by the cantons which elect and pay them. The 167 members of the National Council are paid from federal funds at the rate of four dollars for each day of attendance and an allowance for traveling expenses. Clergymen are not eligible as deputies; every citizen over 21 has the vote and is eligible for election. The Swiss are keen politicians and go industriously to the polls for the election of representatives and for the settlement of the numerous questions referred to their decision by direct vote. Out of 839,114 electors in 1912, no fewer than 529,000 recorded their votes in a referendum held that year on the new insurance law against sickness and accidents.

Under the operation of the federal constitution the Swiss executive, unlike the British Cabinet, is not renewable all at once, but only gradually as the term of office of each member comes to an end. Nor is it dependent for its existence (and this is a highly important point) on the vote of a majority in the Federal Assembly. Yet the Swiss executive, like the British Cabinet, but unlike the American Cabinet, has the right and duty of initiating legislation; but if a measure introduced by it, or having its support, is rejected by the Assembly, that measure merely disappears for the time being. Nothing else happens. There is no political crisis and no general election. A Swiss election causes no uproar. It has become the habit of the Assembly to elect members of the Federal Council to the presidency in the order of their seniority on the Council, and for years past Swiss presidents have succeeded each other as noiselessly and as surely as if they followed each other by right of heredity. With some difference, the State Council is obviously modeled on the United States Senate, but has not the power of ratifying treaties. By means of the referendum the whole body of the electors throughout the country acts as a check upon the elected representatives in the Federal Assembly, and the electors can, by means of the initiative, if necessary also act as a spur. Swiss representatives have far greater freedom of action than those in other countries bearing a party label. They are not bound to any party and may speak and vote like free men, since the rejection of government measure entails no political crisis nor an election, as would be the case elsewhere. In America, where the executive is not dependent for its existence on a vote of a majority, party feeling is nevertheless as predominant as in England: the loyal party man hopes to receive his reward in the shape of some office for himself or patronage for the benefit of friends. All such considerations are entirely absent in Switzerland, where, although party names and organizations have not altogether disappeared, their meaning and importance are negligible, and no organization, however influential and wealthy, can control politics. The referendum and initiative have broken political despotism and party government in Switzerland.

Local government is entirely in the hands of the cantonal authorities. In some of the smaller cantons there is no special administrative machinery; all the male citizens assemble in the open air at stated periods and transact the public business. These assemblies are called Landesgemeinde. The administrations differ in the larger cantons and are carried on by popularly elected representatives; in most of them the referendum exists, while some have also the popular initiative.

Judicial System.— The Federal Tribunal or Bundes-Gericht is stationed in Lausanne and is composed of 24 members with nine supplementary judges appointed by the Federal Assembly. Their term is six years, and they may be re-elected. The president and vice-president hold office for two years and are not eligible for re-election to those posts. The president is paid $3,200 annually; the others $3,000. Divided into three divisions, the tribunal has final jurisdiction in all national suits; private suits in cases where the value in dispute is not less than $600, and in appeal cases involving not less than the same amount. National suits are such in which constitutional or legislative matters are concerned, intercantonal disputes, or appeal against the decisions of federal authorities. It tries treasonable offenses against the confederation, the jury being popularly elected and paid two dollars a day. For ordinary civil and criminal cases each canton has its own judicial system. Capital punishment was abolished in Switzerland by the new constitution of 1874, but since 1879 several cantons have reintroduced the death penalty, which now exists in the 10 cantons of Appenzell-Inner-Rhoden, Fribourg, Lucerne, Obwalden, Schaffhausen, Schwyz, Saint Gall, Uri, Wallis and Zug. Nevertheless, capital punishment is not referred to in the Swiss penal code.

Finance.— Switzerland derives its revenue from the alcohol monopoly, customs, railways, posts, telegraphs, state property and investments, and military service exemption taxes. The revenue gathered for federal purposes amounts, normally, to about $32,500,000, about half from the customs and almost the rest from the public services. The production and sale of alcohol is a federal monopoly and produces nearly $2,000,000. a year profit. The bulk of the proceeds of this latter are divided among the canton governments, who have to expend one-tenth of the amount received in combating alcoholism. The revenue for 1913 (the last normal year) amounted to close on $20,000,000, and the expenditure to $21,062,000. Owing to cost of mobilization and enhanced prices under war conditions the expenditure for 1917 rose to $38,645,140 and the revenue to $35,316,400. The estimates for 1918 stood at over $50,000,000 expenditure. For mobilization the government issued loans for 80,000,000 francs in 1914; 115,000,000 in 1915; 200,000,000 in 1916; 100,000.000 in 1917, and 150,000,000 in 1918. The public debt amounted 1 Jan. 1918 to $149,010,000; including the floating debt the total was $42,578,000. In 1914 there were 385 savings banks with 446,247 depositors and $315,000,000 in deposits. In 1917 the total state property was valued at nearly $29,000,000. The cantons separately raise about $27,500,000 a year, while the total taxation of the country is normally about $60,000,000 annually. The salt monopoly produces about $7,500,000 a year. At the beginning of 1918 there were in circulation 10,880,000 gold coins of the face value of $40,520,000; 58,376 silver coins, face value $11,460,000; 143,700,000 nickel coins, face value $2,774,000 and 102,500,000 copper coins, face value $270,000 — a total face value of $55,024,000. The national bank, opened in 1907, has the exclusive right to issue bank notes, of which it had in circulation on 30 March 1918 to the value of $139,125,860. Switzerland is a party to the Latin Monetary Union with France, Belgium, Italy and Greece. The franc is the unit of currency; its value in terms of United States money is $0.225, roughly 20 cents, or five francs to the dollar.

Swiss Army.— Compulsory universal service has been the root-principle of Switzerland's military system for centuries. Since the reorganization completed in 1912 the army has been brought to a high state of efficiency. The striking force of the Swiss army consists of about 300,000 men, divided into the Elite (20 to 32 years), the Landwehr (33 to 40) and the Landsturm (40 to 48), which number respectively 117,530, 108,900 and 68,000 men. The supplementary services (men of from 20 to 48, who for various reasons are not entirely fit), number 205,000, and the grand total of the whole army is slightly under half a million or one-eighth of the entire population. There are few exemptions except for physical disability and those excused or rejected pay certain taxes instead of rendering service. Liability extends from the 20th to completion of the 48th year; service is distributed as follows: 12 years in the Elite or «Auszug,» eight years in the Landwehr and eight years in the Landsturm. The longest periods of training are the recruits' courses which every man goes through in his first year of service — 65 days for the infantry, 75 for the artillery and 90 for the cavalry — besides which there are compulsory courses in shooting. The younger men (the first line) do seven other annual trainings of 11 days each (14 days in the artillery) before passing into the Landwehr, when they are called out for 11 days every four years; the Landsturm are only called up in time of war. Men convicted of grave offenses are not allowed to join the army and officers and men whose private life is unworthy of their rank and standing are court-martialed and dismissed. In the strictest sense a democratic service, the Swiss army is a model institution, unique in that every would-be officer starts as a private with the ordinary recruits' course, and promotion to the commissioned and non-commissioned ranks is by merit and not by seniority, except that it is conditional on four years' service in each rank. Although officers naturally have to do more work and pass through longer courses of training than the privates, instances of shirking in order to escape promotion do not occur. On the contrary, all through the army both officers and men do a large amount of extra voluntary work. In peace time there are no generals; these are appointed only on mobilization or outbreak of war. The system of promotion from the ranks has the advantage that it obviates any danger of militarism, which always springs from antagonism between people and officers as a class;

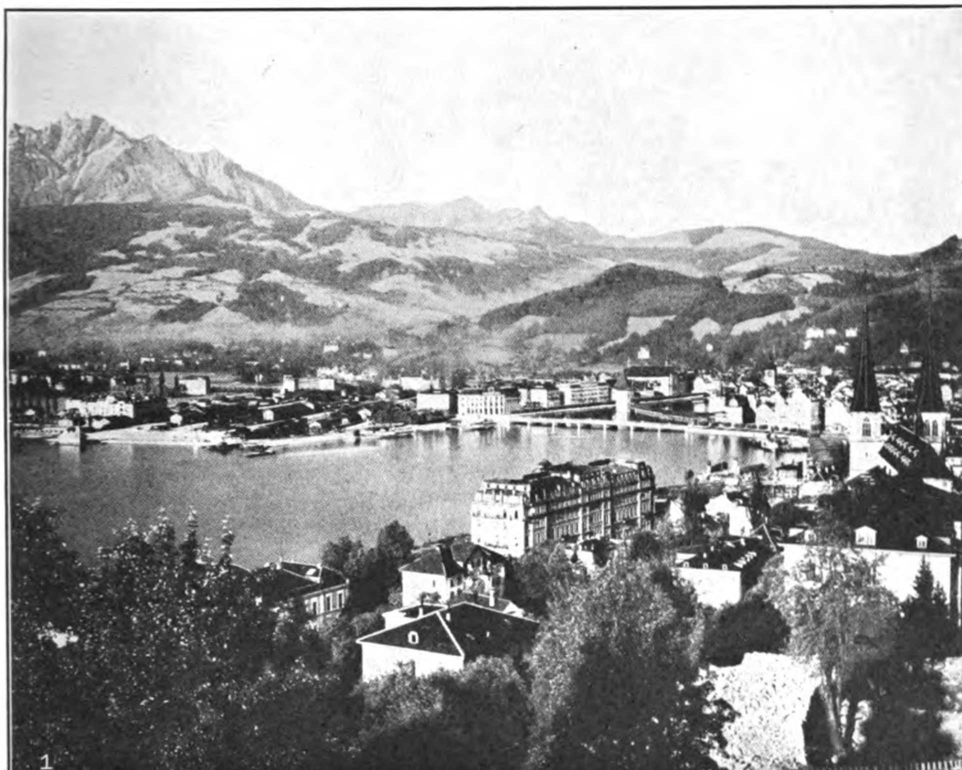
in Switzerland officers as well as men either belong or feel that tney belong to the people, and there is consequently no friction between them. The system also makes physical training obligatory, for it is preceded by compulsory gymnastic training in all the schools and supplemented by a large amount of voluntary gymnastics, drill and shooting practice, which last is the principal cause of the high standard of marksmanship throughout the Swiss army. But apart from target exercise (which is encouraged, while at the same time mobilization is accelerated by the fact that every soldier when he is not out training keeps his rifle and equipment in his own house) the institution of annual trainings tends to produce a high state of physical efficiency throughout the nation.

The composition and organization are thoroughly modern and complete. The infantry (traditionally known as Fusiliers and Carbineers, but for practical purposes are divided into field and mountain infantry) is the main arm. The cavalry consists of dragoons and guides, the former being ranged in independent divisions under the direct orders of the commander-in-chief and the latter brigaded with those divisions. There are altogether 106 battalions, 72 field batteries, 12 howitzer batteries, nine mountain batteries, eight cavalry regiments and 12 squadrons of guides, besides the usual accompaniment of engineers, cyclist, railway and pontoon corps, telegraph section, etc. The fortifications on the southern frontier for the defense of the Saint Gothard pass and the Rhone valley are manned mainly by the Landwehr, which is organized in 56 battalions and 36 squadrons. There are six divisions in the army, each of which belongs to one of the six divisional districts into which the country is divided and each can be worked as a separate army corps. The first consists entirely of French-speaking Swiss, recruited from the cantons of Geneva, Valais, Vaud and Neuchâtel. In the second division three-quarters of the men are French-Swiss, from Fribourg, Neuchâtel and the French Jura. The third, fourth and fifth divisions consist entirely of German-speaking Swiss from the cantons of Bern, Lucerne, Soleure, Basel, Argovie, Saint Gall, Zürich and Schaffhausen. The sixth division (Italians and Rumonsh) is recruited from Ticino, the Grisons and Saint Gall. At the beginning of the European War all six divisions were mobilized so rapidly that in the first week of August 1914 Switzerland was able to post on its frontiers over 250,000 fighting men, well armed and well drilled. The infantry are armed with the Swiss repeating rifle. The field artillery consist of 75's and 120's (howitzers); the mountain artillery of 75's (1906 model) and the heavy artillery of 120's, firing a shell of about 39.68 pounds.

This national militia, which is not a standing army, is administered partly by the cantonal authorities, who have power to promote officers up to the rank of captain. The higher appointments rest with the federal government, which has charge of all general matters of importance. The Swiss consider it an honor to serve in the army and a misfortune to be rejected. Considering its efficiency and the fact that it is raised by conscription, the Swiss army is a comparatively cheap one. The expenditure is 11 francs ($2.20) per head of the population, while 23 francs ($4.60) per head is spent on education. All men rejected on account of physical defects or exempted, such as teachers, clergymen, police, etc., pay a military tax according to income up to the age of 40. Service being the same for all, it is, therefore, a handicap for none. It interferes neither with personal liberty nor with the country's prosperity; it imposes little burden on the national treasury and no burden at all on the national content. In proportion to population Switzerland is one of the richest countries, although it has not an inch of territory beyond its borders. The yearly value of Switzerland's commerce amounts to about $162 per capita of the population, as compared with $107 in England, and the country not only bears the compulsory system, but regards with pride and affection the army which is its result. Owing to its inland position Switzerland has no navy, and no need of one. Yet a "Swiss admiral" did once exist, an Englishman named Colonel Williams, who in 1799 was in the service of the Zürich government and commanded a small fleet on Lake Zürich, with which he was ordered to oppose the French army. When the latter, under Masséna, routed the Austrians and Russians, Williams calmly watched the battle from the lake. Then, enraged at his own inaction, he discharged his crews, scuttled his vessels and took to flight.

History.— Switzerland is believed to have been first peopled by the Rhæti, who were driven from the plains to the mountains by the Helvetii (q.v.), a Celtic tribe. The latter are the oldest inhabitants of the country mentioned in history; they were conquered by the Romans in 58 B.C. and A.D. 10, while the Rhæti were subdued by the same conquerors in 15 B.C. The Romans built military roads over the Great Saint Bernard to Basel and over the Julier Septimer and Splügen to Bregnez and thence to Basel. The chief settlements were Aventicum (Avenches) in the canton of Vaud; Vindonissa, which in the early centuries of the Christian era was the headquarters of a Roman legion with its Rhætian cohorts at the confluence of the Reuss, Aare and Limmat; Augusta Rauracorum (Kaiser Augst) on the left of the Rhine near Basel; and Curia Rhætorum (Coire) in the Grisons. East Switzerland as far as Pfyn in Thurgau and Pfin (*ad fines*) in the Upper Valais, belonged to the province of Rhætia, while Western Switzerland formed part of Gaul. Under Roman dominion Helvetia enjoyed a flourishing trade which covered the land with cities and villages. A trace of that period still exists in the Romanic dialect spoken in some parts of Switzerland. The name Helvetii had become extinct even before the reign of Constantine. About 400 A.D. a great wave of barbarians poured through the peaceful valleys of the Alps, and Huns, Burgundians, Alemanni and Ostrogoths in succession settled in different parts of the country. The Alemanni occupied the whole northern part, where German is now spoken; the Burgundians the western part, where French is spoken; and the Ostrogoths occupied the south, where Italian and Rumonsh are the languages to-day. These races were gradually subdued by the Franks, and by the year 534, under the successors of

SWITZERLAND



1 Lucerne

2 Thurn and the Bernese Alps

Clovis, Switzerland had become a part of the Frankish Empire, which did not take possession of the country with its own nationals, but governed it through appointed officials. Christianity was introduced during this period and the monasteries of Disentis (now a school); Saint Gallen (named for Saint Gallus, an Irish monk, and now a bishop's residence), and Einsiedeln (now one of the most famous pilgrim resorts in the world), were founded, and dukes and counts were appointed as vicegerents of the Frankish kings. Under the successors of Charlemagne, Switzerland was divided: the eastern half was united with the duchy of Alemannia or Swabia (Schwaben), and the western part with the kingdom of Burgundy (912). After the downfall of the latter in 1032 the whole country fell to Germany, which governed it through vicegerents, the dukes of Zähringen. These governors in succession conducted themselves as princes, assumed the name of their castles, and compelled the free inhabitants of their *Gaus* (districts) to acknowledge them as their lords. They were in perpetual enmity with the Burgundian nobles and consequently favored the inhabitants of the towns. They also founded several new towns, such as Bern, Frieburg (Fribourg) and Burgdorf. Throughout the Middle Ages, Switzerland and the Swiss were always in the eye of Europe. At times they presented the spectacles of a patriot people repelling the tyrant and invader with an unearthly courage and good luck; at other times it was that of a warlike clan, safe in the great mountain fastnesses, offering their fighting abilities to the highest bidder and rendering for pay as high a courage and stubborn a fidelity as was ever inspired by love of country. Almost every European nation felt their prowess as enemies or allies. The Swiss was found at every court in some capacity. Peter of Savoy, Prince of West Switzerland, built the great Savoy palace in London, part of which survives to-day as the Savoy Chapel, built on the site in 1505–11; he also built the famous Castle of Chillon on Lake Geneva, immortalized by Byron, and kept great affairs going in both those far-apart countries. It is recorded that Machiavelli prophesied that the Swiss would some day be masters of all Italy, a prediction reasonable enough then in the light of the remarkable military virtue and energy of the Swiss.

As the power of the German emperors declined, the nobles and priests grew ambitious of independence and eager to enrich themselves at the expense of their neighbors. Those of the Swiss towns and smaller communities which had preserved their freedom were compelled by considerations of safety to conclude treaties with the feudal lords of the soil. At the beginning of the 13th century the three forest cantons of Uri, Schwyz and Unterwalden were subject to the then unimportant counts of Hapsburg, who, although they were properly only imperial bailiffs (Vögte), yet regarded themselves as sovereign rulers. This claim the three cantons constantly refused to admit, and eventually (1291) leagued themselves together to oppose the usurpations of the house of Hapsburg. Tradition says that on the night of 7 Nov. 1307, 33 representatives, with Fürst of Uri and his son-in-law Tell, Stauffacher of Schwyz, and Arnold of Melchthal in Unterwalden at their head, met at Rütli, a solitary spot on the Lake of Uri, swore to maintain their ancient independence, and projected a rising of these cantons for 1 Jan. 1308. On the day fixed the rising took place, and the Austrian governors were deposed and expelled. But the events related of Tell are purely legendary. (See TELL). A few years later the three cantons were invaded by the Hapsburgs; but the signal victory at the pass of Morgarten on 15 Nov. 1315, secured the independence of the cantons. The three united cantons were joined by the cities of Lucerne (1332) and Zürich (1351), the cantons of Glarus and Zug (1352), and the city of Bern (1353). Austria, which claimed jurisdiction over three of the newly-added members, namely, the city of Lucerne and the cantons of Glarus and Zug, again invaded the territory of the confederation, but was completely defeated at Sempach (where Arnold of Winkelried is said to have sacrificed his life for the sake of his fellow-countrymen) in 1386, and in 1388 at Näfels. The canton of Appenzell joined the confederation in 1411, and Aargau was wrested from the Austrians in 1415. The third war with Austria terminated in 1460, in favor of the confederation, which obtained Thurgau, Austria being thus deprived of all its possessions in the regions over which Switzerland now extends. Hapsburg Castle still dominates the canton of Argau — a monument of Swiss independence. In 1474, at the instigation of Louis XI of France, the Swiss turned their arms against Charles of Burgundy, invading his country and defeating his army near Héricourt. Charles, in revenge, invaded Switzerland, but the Swiss inflicted severe defeats upon the Burgundians at the three battles of Grandson in Vaud, Morat (Murten) and Nancy in 1476 and 1477, in the last of which Charles was slain. They admitted Freiburg and Solothurn into the confederation in 1481, and about the same time they concluded defensive alliances with several of the neighboring states. Their prosperity rose to such a height that all the courts around, even Austria, sought their friendship and alliance. The last war with Austria broke out in 1498. The Swiss had to undergo a severe struggle, but, victors in six sanguinary battles, they were, by the Peace of Basel in 1499, practically separated from the empire, a separation to which formal and international sanction was given in 1648. That peace ended a triumphant struggle of two centuries. After this war they had no longer any enemy to fear, and their future wars were waged on behalf of foreign powers. In 1501 Basel and Schaffhausen, and in 1513 Appenzell (which had long been an ally), were admitted into full federation. The number of the cantons was thus brought up to 13, at which it remained till 1798. The town and the abbot of Saint Gall and the town of Bienne had seats and votes in the diet without being in full federation; and there were besides six allies of the confederation not enjoying these privileges — the Grisons, Valais, Geneva, Neufchâtel, Mühlhausen, and the bishopric of Basel. In 1516 France gave up to Switzerland the whole of the present canton of Ticino. An alliance between the two countries was formed which lasted until the French Revolution.

In 1518 the Reformation began to make its way into Switzerland, chiefly through the efforts of Zwingli at Zürich. He fell at Kappel (1531), but his work was carried on by Calvin at Geneva. The effect of the Reformation for long was to divide Switzerland into separate camps. Aristocracy and democracy, Protestantism and Catholicism, struggled for the superiority. Internal dissensions, religious and political, continued for nearly 200 years. The last time the two great parties met in arms was at Willmergen in 1712, when victory declared itself for the Protestants. The period of tranquillity that followed was alike favorable to the progress of commerce, agriculture and manufactures, and to the arts and sciences. In almost every department of human knowledge the Swiss of the 18th century, both at home and abroad, acquired distinguished reputation. In the last years of the century the ferment of the French Revolution spread to Switzerland; and in 1798 the ancient confederation was replaced by the Helvetian Republic, founded on the ruins of the ancient liberties of the nation, which lasted four years. In 1803 Napoleon I organized a new confederation, composed of 19 cantons, by the addition of Aargau, Grisons, Saint Gall, Ticino, Thurgau and Pays de Vaud. In 1815, by the Federal Pact of Zürich Neufchâtel, Geneva and Valais were admitted into the confederacy, and the number of the cantons was thus brought up to 22. This confederacy was acknowledged by the Congress of Vienna, which proclaimed the perpetual neutrality of Switzerland, and the inviolability of its soil. Again in 1830 and in 1848, Switzerland was affected by the revolutionary movement in France, and a new federal constitution was introduced in the latter year. During the revolutionary commotions of 1848 Neufchâtel set aside its monarchical form of government and adopted a republican one, and in 1857 it was put upon the same footing with the other cantons. Since that time the annals of Switzerland have little to record beyond the fact of constant moral and material progress. A revision of the federal constitution was adopted after a protracted agitation on 19 April 1874, from which time the cantons gradually adopted the referendum and the initiative. While this agitation was going on several of the individual cantons set the example of revising their constitutions. In this proceeding Zürich led the way, appointing a special council for the purpose in January 1868. It was followed by Bern, Aargau, Thurgau, Solothurn, and other cantons. All the modifications made were in a democratic direction. The chief opposition to the project of a revision of the federal constitution proceeded from the French cantons and the Ultramontane party, the former fearing that in consequence of a revision of the constitution in the direction aimed at, that of giving more power to the central authorities, they would be gradually Germanized, the latter believing that the influence of their party in those cantons where it was numerically strong would be curtailed. But in spite of this opposition the Federal Assembly, on 21 Dec. 1869, adopted the principle of a revision, and elected a committee to prepare a scheme for the purpose. The project of revision drawn up by this committee was laid before the Federal Assembly in the session of 1871–72, and after being accepted there was submitted to the people on 12 May 1872, an article of the constitution then in force requiring that any proposed alteration of it must, before being adopted, be sanctioned by a majority of the people and of the cantons. On this occasion the project was rejected by a small majority; but a new one was drawn up and accepted on the date already mentioned, 19 April 1874. The new constitution gives more homogeneity to the confederacy by assigning to the federal authorities more power in matters relating to law, the army, the church, and education. The laws of the various cantons are partially assimilated; the management of the cantonal contingents to the army is no longer left entirely to the cantons themselves; the ecclesiastical authorities are completely subjected to the civil power; and primary education is made compulsory and secular. Since then two or three partial revisions have been carried out. A constitutional modification, for instance, was passed by the National Council in 1890 to the effect that in future when a revision of the federal constitution, or the admission into it of a new article, is proposed by popular initiative, this proposal must be supported by the votes of at least 50,000 citizens possessed of the right of voting, and not 30,000 as previously. In 1891 the 600th anniversary of Swiss nationality was celebrated.

The more important events in Swiss history of recent years may be briefly summarized. On the last day of 1898 Switzerland was admitted by the United States as a favored nation. In 1900 the nation rejected the «double initiative,» a scheme to elect members of the National Council by proportional representation. The new palace of the Swiss parliament was opened in 1902. In the same year a brief rupture with Italy occurred. Agreements were arrived at during 1903 for the construction of the Jura and Simplon tunnels; a new army bill was passed in 1907, when a British military commission arrived at Basel to study the Swiss army system. In 1908 the sale and manufacture of absinthe were entirely prohibited in the country. During 1909 and 1910 serious damage was caused by floods and avalanches. Progressive industrial development calls for a large supply of labor which Switzerland is unable to supply; becoming every year less of an agricultural country, large quantities of food have to be imported, while the number of factory hands has more than doubled in 25 years. The population of the country districts shows little increase; that of the towns is growing rapidly, mainly due to foreign immigration from Italy, France and, above all, from Germany. During the European War the position of Switzerland was one of extreme difficulty. Need of coal and iron compelled the republic to enter into agreements with the Central Powers to supply them with foodstuffs. Besides maintaining its army on a war footing for the duration of the war, Switzerland became a clearing-house for the refugees, wounded and prisoners of all the belligerents, while international diplomats and exiled rulers made it their headquarters. A noteworthy statement of Swiss policy was made in a memorandum presented in February 1919 by the Federal Council to the Peace Conference in Paris. In this document special emphasis is laid on Swiss neutrality, which «is not chosen according to circumstances, but is permanent»

— a fundamental principle of the Swiss state since the beginning of the 16th century. «As in the past, so in the future, Switzerland must remain the faithful guardian of the passes of the Alps. . . . When all relations between the belligerents were broken off, Switzerland was able, thanks to its neutrality, to undertake the grateful task of carrying out a philanthropic activity which saved the world from an accentuation of its sufferings.» Switzerland welcomed the creation of a League of Nations and, as the oldest of existing republics, «would deem it an honor to bring into the League of Nations the experience acquired in the course of centuries.» The determined insistence on neutrality by Switzerland — except in case of self-defense — places that country in a peculiar position with regard to the League of Nations. As pointed out by Professor Borgeaud in a pamphlet, 'La Suisse et la Société des Nations' (Geneva 1919), neutrality implies sovereignty, a principle inconsistent with the general spirit of the League — unless, indeed, the League itself concedes this privilege for special international reasons. In a remarkable speech delivered before the National Council in August 1918 President Calonder first called attention to this point; though supporting intervention to end the war, he declared that Swiss neutrality prevented Switzerland from forcing itself as a peacemaker. Sturdy independence, freedom of action and avoidance of foreign entanglements or obligations is the keynote of the Swiss Republic. In a state paper dated 15 Nov. 1690 occurs this passage (in French): «The Swiss have two religions in their country, which divide them at times; but they have only one liberty, which they cherish above all: this reunites them always, and will reunite them for ever.»

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Henri F. Klein,
Editorial Staff of The Americana.

SWORD, The, a weapon used in personal combat for cutting or thrusting, one of the most ancient and highly esteemed of all weapons. No sooner had the art of working metals been discovered than it made its appearance, replacing almost at once the crude axe of the Stone Age. The earliest swords, of which any authentic records exist, were those of the Assyrians, the Gauls and the Greeks. These swords were double edged, straight or leaf-shaped, and were made of bronze, the art of tempering steel not having then been discovered. The Roman sword, which was made of steel, was short, straight and double edged, having its point cut at an obtuse angle. The swords of the Franks were straight, about 30 inches in length with a tapering point. None of these swords appear to have offered much protection to the hand.

During the Middle Ages the sword was lengthened, while still retaining its general Frankish shape and quillons (cross-pieces) were added for the protection of the hand. A narrow-bladed sword called the estoc, used principally for thrusting, was often carried attached to the saddle by mounted men, the heavy sword being worn upon the person at the same time. A dagger called the miséricorde (dagger of mercy) was worn on the right side by knights, and used to dispatch their fallen foes.

The German lansquenets, or mercenary foot soldiers, used a two-handed sword some six feet in length. On the march this ponderous weapon was worn slung over the back. In wielding the heavy swords of the Middle Ages, the forefinger was often hooked over the right quillon to strengthen the grasp. This forefinger being unprotected (except by the gauntlet) was frequently injured and so, for its protection, a little ring was placed in front of the quillon through which the finger was passed. For the sake of symmetry another ring of the same kind was added to the left quillon, the two rings being termed the «pas d'ane.» Side rings were next added for the protection of the hand and the right quillon was curved upward so as to form the «knuckle bow.» A thumb ring was also sometimes added, the Germans being especially fond of this device. During the 16th century the sword became much lighter, the striking of heavy blows having become less of a necessity owing to the discarding of armor on account of the invention of gunpowder. A cup-shaped guard was added to the quillons (which were generally straight, the knuckle bow being retained as a separate piece) and the weapon became a rapier, the point of which rather than the edge was used in making an attack. With the early rapier a dagger was worn, which when fighting was held in the left hand and used for parrying. Later a cloak was used for the same purpose. As the science of fence became better understood, however, all secondary protections were discarded, and the rapier became a weapon of both offense and defense. Rapiers were often highly ornamented and the guards were frequently of fanciful design. The best of them came from Spain, Toledo being especially noted for the excellence of her blades.

Shortly before the beginning of the 18th century the rapier was supplanted to a great extent by the colichemarde, a weapon with a hilt like our modern small sword, the marked peculiarity of which was that its blade was wide for about half its length and narrow for the other half. About 1760 the colichemarde gave way to the small sword, a very light weapon, having a small circular guard, a knuckle bow and a narrow straight blade. The foil used in fencing which represents the small sword is about 33 inches in length with a quadrangular blade and a bell or ring guard. Italian foils have quillons, French ones do not. The duelling sword is a heavier kind of foil, having a triangular blade tapering to a very fine point. A broadsword is a sword that has a cutting edge. It may be either straight or curved, single or double edged. It is essentially a military weapon and is in use in all armies. In the United States army a form of sabre is used varying from 30 to 34 inches in length. In the European War the sword has come into disuse among infantry officers owing to the lack of opportunity for its employment in trench warfare and the dangerous distinctiveness which it gives to those who bear it.

The sabre which is the best known form of broadsword is single edged. Its blade, which is usually somewhat curved, is thickest at the back, from whence it becomes gradually thinner toward the edge. Its guard consists of a strong knuckle bow often terminating in a solid piece, which amply protects the hand. The scimetar, a light form of sabre having a very pronouncedly curved blade is the favorite weapon of the East. Damascus was formerly noted for the excellence of her scimetar blades. The cutlass is a short heavy broadsword which is in use in most of the navies of the world. The machete, a weapon much used in Cuba, is shorter than the cutlass and lacks the protecting guard for the hand. The claymore, which may be called the national weapon of Scotland, is a heavy straight broadsword having a very elaborate basket hilt.

The schlaeger, the weapon used by the German students in their university duels, is a long straight sword with a very sharp edge, having a solid metal guard which completely encases the hand. The sword bayonet is a short sword adapted for use either with or without the rifle.

The long sword of the Japanese is a weapon some two and a half to three feet in length, with a heavily backed blade, a sharp cutting edge, a long handle and a small round guard. Their short sword is like the other but only about half as long. In olden times both of these swords were worn together thrust through the girdle by the samurai, a privileged fighting class corresponding to the knights of the Middle Ages. It was with the short sword that hara-kiri (self dispatch) was committed in order to avoid the disgrace of dying at the hands of the public executioner, the samurai being accorded this right. When fighting, the short sword served as an extra weapon in case the long sword became lost out of the hand, or broken. (See FENCING). Consult Lacombe's 'Arms and Armour'; Castle's 'Schools and Masters of Fence'; Hutton's 'The Sword and the Centuries.'

FRED GILBERT BLAKESLEE,
Late Swordmaster First Regm't C. N. G.

SWORD-DANCE, a dance in which swords and movements made by them form an important part. In the modern sword dance as practised among the Highlanders of Scotland, the performer shows his ability and skill by dancing among the blades without cutting himself.

SWORD FERN. See *Filicales*, under FERNS AND FERN ALLIES.

SWORD-LILY. See GLADIOLUS.

SWORDFISH, an enormous mackerel-like fish (*Xiphias gladius*), representing alone the world-wide family *Xiphiidæ*. It has an elongate mackerel-shaped body which may equal in size that of the largest sharks, and whose muscles are astonishingly strong. A powerful forked tail, a lofty, sail-like dorsal fin, usually divided in adults, but continuous in the young, and other strong fins, give the creature a power and speed in swimming equaled by few oceanic animals. The skin is naked, more or less rough, and the flesh red in color and rich in flavor is greatly enjoyed when eaten. These fishes are predatory, obtaining their food by fierce forays upon flocks of lesser fishes. Their strength and sharp teeth are supplemented by the prolongation of the fore part of the skull into a horizontally flattened «sword,» composed of the consolidated vomer, ethmoid, and premaxillary bones. The excellence of this weapon and the power of attack is attested by the frequent piercing of boats and even of large wooden ships, through which the sword has been deeply thrust before breaking off. Although occasionally seen in the Pacific, the swordfish is characteristic of and numerous only in the North Atlantic, the Mediterranean Sea, and about the Antilles, where in summer it approaches the shore, in pursuit of schools of spawning fishes, and itself becomes the object of a profitable fishery, especially in Italian waters. Along the northern seaboard of the United States this is regarded as a prime summer sport. The fishermen cruise a few miles from the coast in small schooners, having at the extremity of the bowsprit (from which the jibboom has been removed) a small platform supporting a belt-like rail of iron at the height of a man's waist, within which a harpooner may stand securely while his arms are free. Having sighted a swordfish, visible by its projecting backfin, the vessel is steered up to it and a barbed harpoon is thrown to which is attached a rope by which the catch is hauled aboard. Consult Goode, G. B., 'Fishery Industries' (Washington 1884).

SWORDS, Order of. See ORDERS (ROYAL) AND DECORATIONS.

SYBARIS, sĭb'ạ-rĭs, an ancient Greek city and colony of Lower Italy, in Lucania, on the Gulf of Tarentum, not far from the site of the later town of Thurli. Tradition ascribes its building to a colony of Achæans and Trœzenians about 720 B.C. It rapidly rose to a high degree of prosperity, but enervated by the mildness of the climate, the richness of the soil and their great wealth, the inhabitants became proverbial for their luxury and voluptuousness. In a war with Crotona the city of Sybaris is said to have brought into the field 300,000 men, while the forces of the former amounted to but 100,000. The Crotonians, however, were victorious and totally destroyed Sybaris by turning the waters of the river Crathis against it (510 B.C.). The inhabitants of the town dispersed themselves for the most part over the other Greek cities of Lower Italy. Sybarite is still used to signify an effeminate voluptuary. In 1879 and in 1887 excavations revealed two great cemeteries but the true site of the city remains undetermined. Consult *Notizie degli Scavi* (Rome 1879–88) and Orsi, P., 'Atti del congresso di scienze storiche' (Vol. I, Rome 1904).

SYCAMORE, sĭk'ạ-mōr, Ill., city, county-seat of DeKalb County, on the Chicago and Great Western and the Chicago and Northwestern railroads, about 55 miles west of Chicago. The city was founded in 1836. It is in an agricultural and stock-raising region and has considerable manufacturing interests. The chief manufacturing establishments are flour mills, insulated wire works, brick and tile works, soap factories, wagon and carriage works, agricultural implement works, varnish and furniture factories, canning establishments and creameries. There are large establishments for preparing fruit and vegetables for shipment. There are 12 churches, a young ladies' seminary and public graded schools. The national bank has a capital of $50,000; there is also a private bank. Pop. about 3,800.

SYCAMORE, a name applied originally to *Ficus sycomorus,* a tree known in biblical times and places, and the legendary one chosen by Zacchæus to climb into for a sight of the Saviour. It is a species of fig, an evergreen timber tree, flourishing in Egypt, which supplied an inferior coarse-grained wood for ordinary purposes and for mummy cases. A famous Egyptian statue of an old man was carved out of a block of sycamore wood about 4000 B.C. The thick foliage, resembling that of the mulberry, makes the sycamore a desirable shade-tree and it is still planted for this reason in Egypt. The fruit is borne directly on trunk and branches, edible and sweet-flavored and is a large item of food among the lower classes. The ripening of the figs is hastened by making incisions in the apexes. In the Middle Ages a European maple, *Acer pseudo-plantanus,* was selected to represent the tree of Zacchæus in the old miracle plays, on account of its dense foliage. It is a tall, very handsome tree of quick growth and living for perhaps 200 years. The leaves are large and have acute lobes, somewhat resembling those of the plane, and the yellowish flowers droop in terminal racemes. The bark is smooth, often peeling off in large flakes, leaving patches of lighter shade, the sap is saccharine and the wood is hard and white, although with a brownish heart, and takes a fine polish, being used by wheelwrights, turners, cabinet-makers and wood-carvers and for musical instruments. Sycamore endures sea and mountain winds better than most timber trees and is, therefore, planted for its shade in exposed places. Certain of these trees in Scotland were known as dool-trees, or grief-trees, because they formed informal gibbets on which to hang the enemies of powerful barons.

Perhaps because of the likeness in foliage and the stripping of the bark, the name of sycamore has been again transferred to the American plane-tree (*Platanus occidentalis*) better called buttonwood. This is one of the largest American trees with awkward, twisted, wide-spreading limbs which, however, when the tree is fully leaved out, forms a broad pyramidal head. The bark is smooth, that of the upper portion flaking off in pieces each year, leaving whitish patches, which are very conspicuous in winter. The large leaves range from simple coarse-toothed to distinctly deltoid and three-lobed blades. The flowers are clustered in compact round balls, with from three to eight minute petals and sepals; the fruit-heads retain this globose form and are composed of obpyramidal nutlets, having long, nearly erect hairs at the base. They are usually solitary and swing on long peduncles during the winter, only falling apart in the early spring. The reddish-brown wood is chiefly useful for cigar-boxes and is compact and difficult to split or to work.

The Australian sycamores are *Sterculia lurida* and the white sycamore *Cryptocarya obovata,* one of the native nutmegs, and a large tree yielding serviceable white timber. *Melia azedarach* is the false sycamore, the large tree more commonly known as the pride-of-China tree.

SYCEE (sī-sē') **SILVER,** the fine silver of China, cast into ingots weighing commonly rather more than one pound troy. They are marked with the seal of some banker or assayer as a guarantee of purity.

SYCOSIS, a pustular disease of the skin of the bearded face. It is often called barbers' itch (q.v.) and may be regarded as a form of that disorder. The usual treatment consists of application of carbolic acid, zinc ointments, ichthyol, sulphur or oil of cade.

SYDENHAM, Charles Edward Poulett Thomson, 1st BARON, British statesman and governor-general of Canada: b. Wimbledon, Surrey, 13 Sept. 1799; d. Kingston, Canada, 19 Sept. 1841. He was the son of a London merchant and spent some time in Russia in connection with his father's business. He was elected to the House of Commons in 1826 and in 1830 became a member of the Grey Cabinet as vice-president of the board of trade, of which he in 1834 became president and treasurer of the Navy. He became a recognized authority on financial matters and he was an earnest supporter of free trade. He was appointed governor-general of Canada in 1839 and it was under his administration that the union of Upper and Lower Canada was effected and a new constitution established. For his services in connection with this difficult undertaking he was in 1840 granted a peerage. He was preparing to return to England when he met his death through a hunting accident. Consult Poulett-Scrope, G. J., 'Memoirs of Charles, Lord Sydenham' (1843).

SYDENHAM, Thomas («THE ENGLISH HIPPOCRATES»), English physician: b. Wynford Eagle, Dorset, 10 Sept. 1624; d. London, 29 Dec. 1689. He entered Oxford University in 1642 but his studies were interrupted by service as an officer in the Army of Parliament. He was graduated bachelor of medicine at Oxford in 1648 and was elected a fellow of All Souls College, but his medical studies were again interrupted by military service. He began practice at Westminster about 1655, for some time still giving much attention to politics. He was licensed by the Royal College of Physicians in 1663 and took his M.D. at Cambridge University in 1676. While his medical studies were much interrupted and his early practice was without a medical license he made remarkable progress. He developed powers of diagnosis amounting to genius and he followed the method of Hippocrates in watching the progress of the patient and assisting nature in its effort to throw off disease. His theories were backed by his notable success in treating patients; and by his strong sense and plain manner of dealing with matters hitherto cloaked with professional mystery. He also kept mainly to simple prescriptions instead of the involved sort in vogue. He received recognition from abroad comparatively early in his career, his fame being largely augmented by his writings; but he made many enemies in the medical profession at home, although he also enjoyed the loyal support of many notable members of his profession. He made important contributions to medical science in his study of gout, of which he was a victim; his observations of epidemic diseases through a number of seasons and distinguished several that were formerly confused; introduced the cooling method of treating smallpox; was the first to use a tincture of opium, laudanum; and initiated the use of Peruvian bark in treating malaria. His scorn for dogmatic theories was intense and he was known in the case of a patient whose strength had been vitiated by the weakening processes of the day to prescribe food instead of medicine — an unheard-of procedure. His doctrines came into full recognition in the early part of the 18th century and it was then that the custom of designating him the «English Hippocrates» was inaugurated. However, while he felt keenly the antagonism evinced toward him by many members of his profession, he enjoyed a uniformly successful career and never suffered the ostracism endured by many pioneers in new theories of medicine. Author of 'Observationes medicæ' (1676); 'Tractatus de podagra et hydrope' (1683); 'Schedula monitoria de novæ febris ingressu' (1686); 'Processus integri' (1692), etc. The best edition of his works is that of the Sydenham Society, edited by W. A. Greenhill (2d ed., 1844). Little is known of his personal life, but of the numerous sketches of his career appended to editions of his works the most interesting is his own account of his theories and practices in the introduction to 'Observationes medicæ' (1676). Consult also Picard, F., 'Sydenham, sa vie, sa œuvres' (Paris 1889); Payne, J. F., 'T. Sydenham' (London 1900).

SYDNEY, sĭd'nĭ, Australia, capital of New South Wales, on Port Jackson, was the first city founded in Australia, by British colonists. Its selection was due to the beautiful site and the advantages offered by streams and adjacent bays. The principal streets are lined by handsome residences and commercial houses. The important buildings include the government offices — of white stone in Italian style; — the magnificent town-hall, with a high tower and fine organ; banks; post and telegraph offices; government house, a castellated building of fine Gothic architecture; the university, a vast edifice, also Elizabethan Gothic; together with the associated colleges, including the Woman's College, Saint Mary's Cathedral (Roman Catholic), a Byzantine synagogue, exchange, custom-house, mint, parliament houses, hospitals, asylums, and the Queen Victoria Market. Domain, Hyde Moore, and Centennial parks and the Botanical Gardens are extensive; the racecourse comprises 202 acres. The Australian Museum, founded in 1836, is the oldest institution of the kind in Australia. Its erection cost £59,000. It contains a very large botanical garden, a technological exhibit, and a library, which, together with other libraries in the city, numbers 240,743 works. The slaughter-houses and water-supply system are owned by the city and the tramway system is owned by the state. There are manufactories of glass, pottery, wagons, boots and shoes, stoves, hardware, tobacco, etc.

The University of Sydney dates from 1852, receiving its royal charter in 1858. Women students have been admitted since 1881. Port Jackson is of vast proportions, and accessible to the largest vessels, penetrating the country for 20 miles, and sending out branches in all directions. The shores present a bold and rugged aspect. Four companies operate ferries to and from Sydney over the waters of Port Jackson, which carry nearly 24,000,000 passengers annually. This service and equipment — the best boats are double-ended screw-boats — are said to be the equal of any in the world. Sydney is near a coal-formation extending over several hundred miles in East Australia, and is the centre of trade for the pastoral and mineral regions of the western districts, connected with an extensive railway system. The various manufacturing industries are well represented in the city, and its trade is large and growing. Sydney was founded in 1788. The discovery of gold in 1851 stimulated its development. On 1 Jan. 1901 the installation of Earl Hopetoun as first governor-general of the Australian Commonwealth took place here, consummating the federation of Australia.

An outbreak of bubonic plague in 1900, supposed to have been due to the introduction of plague-stricken rats brought in foreign vessels

SYDNEY, AUSTRALIA

1 Sidney, looking east from George street into Bridge street

2 The beautiful residence suburb of Sydney. The house at the left of the flag-staff, near the centre, is "Cranbrook," the home of the Governor of New South Wales

from afflicted ports, led, in 1901, to the formation of a board of port overseers, called the Sydney Harbor Trust. This commission assumed control of all the wharves, docks and harbors, and considerably improved shipping at Sydney. Sydney has 103¾ miles of electric tramways, mostly under municipal control. Pop. 648,746.

SYDNEY, Canada, city, chief port of entry of Cape Breton Island and capital of Cape Breton County, province of Nova Scotia, situated on the southwest arm of Sydney harbor, 285 miles northeast of Halifax; and on the Intercolonial and the Sydney and Louisburg railroads and on the Sydney and Glace Bay Electric Railway. Of these the most important is the great works of the Dominion Iron and Steel Company, employing 3,000 men and turning out 500 tons of steel rails daily. The shipping of coal is also an important industry employing great numbers of men. Among other industries are chemical works, iron and brass foundries, railway repair shops, slag cement works, wood factories, brewery and bottling works. The value of its manufactures reach about $11,000,000 annually. There are five banks located in the city. The chief publications are two daily and three weekly newspapers, one of which the *Mac Talla* is published in pure Gælic. There are 13 churches in the city, branches of the Y. M. C. A. and the Salvation Army, and a Catholic Young Men's Club. Among the public institutions are the county insane asylum and a large public library. The most prominent public buildings are the customs building, the new courthouse, city hall and the new county academy. The educational facilities include a high school, Sydney Academy, School of Mining and Engineering, Catholic convent schools, and a business college. Sydney was founded in 1784 by United Empire Loyalists. It became an incorporated town in 1885 and chartered as a city in 1904. Municipal affairs are administered by a city council consisting of a mayor elected every year, and 10 aldermen, representing five wards and elected for a term of two years. The city owns and operates its waterworks. Pop. 17,723.

SYDNEY MINES, Canada, town in Cape Breton Island and County, province of Nova Scotia, on the northern arm of Sydney Harbor, three miles north-northwest of North Sydney, and connected with that city by electric railway. The town owes its existence to the Nova Scotia Steel and Coal Company, whose mines are the oldest in Canada, coal having been mined there as early as 1785. A large steel plant is also located there, and these two industries employ 2,500 persons. The town government consists of a mayor, elected yearly, and a council of eight members elected every two years. Pop. 7,470.

SYENITE, as at present understood in petrography, a notocrystalline rock in which the chief feldspar is orthoclase, and in which quartz is absent. Originally it was used for a hornblendic granite such as occurs at Syene (now Assuan), Egypt, where it was quarried for obelisks. Typical syenite contains orthoclase and hornblende; those with biotite are called mica syenites. Some plagioclase is always present, and besides this, magnetite, apatite and zircon are invariable. See NEPHELITE.

SYKES, Frederick Henry, American college president: b. Queensville, Ontario, 13 Oct. 1863; d. Cambridge, Mass., 14 Oct. 1917. He was graduated at Toronto University in 1885, and in 1891–95 was student, scholar and Fellow at Johns Hopkins University, where he took his Ph.D. in 1894. He engaged in teaching and in 1903 became professor of literature and director of extension teaching at Columbia University; and he was professor of English and director of technical education at Teachers' College, Columbia, in 1903–13. From its organization in 1913 until 1917 he was president of the Connecticut College for Women. He was general editor of Scribner's 'English Classics Series'; and author of numerous textbooks on English composition and of 'French Elements in Middle English' (1899); 'Syllabus of Lectures on Shakespeare' (1903); 'Lectures of the History of English Literature in the Nineteenth Century' (1904), etc.

SYKES, George, American soldier: b. Dover, Del., 9 Oct. 1822; d. Brownsville, Tex., 9 Feb. 1880. He was graduated at the United States Military Academy in 1842. He was engaged in the closing scenes of the Seminole War and later in Texas, and served through the Mexican War. He was afterward on duty at western army posts and engaged in Indian warfare, and in 1855 was promoted captain. He was commissioned major of the 14th United States Infantry soon after the outbreak of the Civil War, participated in the battle of Bull Run, was commissioned brigadier-general of volunteers 28 Sept. 1861 and major-general 29 Nov. 1862. He commanded the Fifth Army corps at the battle of Gettysburg, and in April 1864 was transferred to duty in Kansas. He was brevetted brigadier-general in the regular army in 1865 in recognition of his services at Gettysburg and throughout the war. He became colonel of the 20th Infantry in 1868, and spent the remainder of his life at different western army posts. Congress appropriated funds for his burial at West Point, where a monument was erected to him.

SYLLABUS, a document issued by Pope Pius IX, 8 Dec. 1864, which condemned 80 current doctrines of the age as heresies. It is a summary or collection of errors previously reprobated in various allocutions and encyclicals. It is a condemnation of the intellectual, social, and religious heresies, characteristic of modern times as these are in opposition to Roman Catholic doctrines. It was divided into 10 chapters each containing several propositions with reference to their previous condemnations under the following general heads: (1) Pantheism, Naturalism and Absolute Rationalism; (2) Moderate Rationalism; (3) Indifferentism and Latitudinarianism; (4) Socialism, Communism and Secret Societies; (5) The Assertion of the Supremacy of the Civil Power over the Church; (6) The right of the State to interfere in Spiritual things; (7) Morality independent or religious sanction; (8) The Sufficiency of merely Civil Marriage; (9) the Denial of the Temporal Independence of the Papacy; (10) Falsely styled "Liberalism." The *Syllabus Errorum* was the occasion of much controversy and was seized upon by the German government as a pretext of the famous May Laws against the Roman Catholic Church in that country. The syllabus reasserts all the claims of the mediæval papacy. It provoked conflicts between the papal and the civil power in Prussia, Austria and Brazil. «Syllabus» is the name also used for a decree of Pius X (1907), condemning modernism in 65 propositions.

SYLLOGISM, *in logic,* an argument stated in full logical form, so that its conclusiveness is manifest from the structure of the expression alone, without any regard to the meaning of the terms. A perfect syllogism comprises three and not more than three propositions, the third being the one to be proved; this is called the «conclusion»; the other two, called the «premises,» contain the means by which the conclusion is arrived at. A syllogism may be represented thus in symbols,

All A is B,
All C is A,
∴ All C is B.

Or with words instead of symbols:

All metals are elements,
Lead is a metal,
∴ Lead is an element.

This syllogism is valid, because the conclusion logically follows from the premises. For the «figures» and «moods» of the syllogism and the rules for the construction of syllogism see LOGIC.

SYLPHS, in ancient mythology, the name given to the elementary spirits of the air in the polytheistic-pantheistic system of the Paracelsists. The sylphs, like the other elemental spirits — the salamanders or spirits of fire, the gnomes or spirits of earth and the undines or spirits of water — form the link between immaterial and material beings, for though, like men, they eat, drink, speak, travel, sicken and beget children, they resemble the more elevated spirits in the litheness and transparency of their bodies and their rapidity of movement; they also know more of the present and the future than man does. They have no soul, and consequently suffer annihilation after death. Consult Paracelsus, ‹Liber de Nymphis, Sylphis, Pygmæis et Salamandris et Cæterio Spiritibus› (Basel ed., 1590).

SYLT, sĭlt, Germany, an island in the North Sea, near the coast of Schleswig-Holstein. It is 22 miles in length, and has an area of 40 square miles. It consists largely of sand dunes with some cliffs,— especially near Kampen. The Friesian inhabitants are chiefly occupied in agriculture, stock-raising and duck-trapping, and are renowed as stalwart sailors. The dialect is peculiar, but German is the school and church language. The principal town is Keitum; the port is near Munkmarsh, connected by rail with Westerland. Lighthouses stand between Wenningstadt and Kampen and on the northern point of land. There is good sea-bathing. Pop. about 5,000.

SYLVANITE, a native telluride of gold and silver, containing 24.5 per cent gold and 13.4 per cent of silver. It usually occurs massive, but is often seen in curious skeleton crystallizations, due to twinning, and somewhat resembling the written Hebrew characters, giving rise to the name, «graphic tellurium.» Individual crystals are rare and of highly complex, monoclinic forms, with perfect clinopinacoidal cleavage. It is brittle; fracture uneven; hardness only 1.5 to 2; specific gravity very high, 7.9 to 8.3; lustre brilliant, metallic; color usually silver-white or slightly yellowish; streak gray. It is an important ore of gold and silver in Transylvania (whence its name), Colorado and California.

SYLVANUS, sĭl-vā'nŭs, in Roman mythology, a rural deity, who is represented as half a man and half a goat.

SYLVESTER, James Joseph, English mathematician: b. London, 3 Sept. 1814; d. there, 15 March 1897. He was of Jewish parentage and was educated at Cambridge University, where, however, his religion prevented his taking his degree until after the passing of the Tests Act in 1872; but he took his degree at Trinity College, Dublin, in 1841. He became professor of natural history at the University of London in 1837; and in 1841 was called to the chair of mathematics at the University of Virginia. He remained there but a short time, his frank expression of his opinion of the slavery question making his stay impracticable. He was connected with a firm of actuaries in London in 1845–55, meantime writing brilliantly on mathematics. In 1855–70 he was professor of mathematics at the Royal Military Academy, Woolwich. In 1877–83 he was professor of mathematics at the newly-established Johns Hopkins University; and while in America founded and was the first editor of the *American Journal of Mathematics.* He was called in 1883 to the Savilian chair of geometry at Oxford University and retained it until his death, although he was not on active duty from 1892, when his sight failed. From 1870 he was recognized as one of the leading mathematicians of the world. He published a vast amount of original work, chiefly in the form of contributions to scientific periodicals and to learned societies. His researches dealt principally with algebraic forms, although he also made contributions to analytical and pure geometry, mechanics, optics and astronomy. He exerted a profound influence upon the study of higher mathematics in America as well as in Europe, and his genius as an inventor of mathematics was accompanied by remarkable facility in instructing and inspiring his students. He was also an able linguist and was deeply interested in verse making, although he failed to make a name in that field. He wrote in this connection ‹The Laws of Verse› (1870). He was elected a Fellow of the Royal Society in 1839 and was the recipient of many honors from universities and learned societies both at home and abroad. His mathematical works were edited by Baker, H. F., ‹Collected Mathematical Papers› (2 vols., New York 1904–10).

SYLVESTER, sĭl-vĕs'tẽr, **Joshua,** English poet: b. 1563; d. Middleburg, Holland, 28 Sept. 1618. He is remembered by reason of his translation into English of the ‹Divine Weekes and Workes› of Du Bartas, a French Huguenot nobleman. It was especially popular with the Puritans in both the Old and New World, and was one of the sources of inspiration for Milton's ‹Paradise Lost.› Anne Bradstreet, the New England «Tenth Muse,» was an enthusiastic admirer of Du Bartas, known to her through Sylvester's version, and modeled her literary style upon Sylvester's somewhat exaggerated version of the strained pedantry of the original. Sylvester, in order to gain the favor of James I, whose dislike of tobacco was well known, published in 1615 an anti-tobacco tract, 'Tobacco Battered and the Pipes Shattered.' His works were edited by A. B. Grosart (2 vols., London 1878).

SYLVESTER. See SILVESTER.

SYLVITE, native potassium chloride, KCl, isomorphous with halite or common salt, crystallizing in the isometric system. Its habit is cubic, the crystals often modified by the octahedron. It usually occurs in granular or columnar masses, or compact. The crystals have perfect cubic cleavage; fracture uneven; brittle; hardness, 2; specific gravity, 1.98; lustre vitreous; usually colorless or white; transparent when pure. It is soluble in three parts of water and tastes slightly more bitter than common salt, like which it is highly diathermanous. It is mined in Galicia and very extensively at Stassfurt and Leopoldshall in Prussia, the production in 1902 amounting to 181,341 metric tons. It is used in the manufacture of potassium salts, especially the nitrate (saltpetre) and the carbonate (potash). It is also called sylvine and sylvinite. See POTASSIUM.

SYLVIUS, Jacobus (Latinized name of JACQUES DUBOIS), French anatomist: b. Amiens, 1478; d. Paris, 14 Jan. 1555. He early devoted himself to mathematics and the learned languages, but in middle life turned to medicine and took his degree at the University of Montpellier, later entering the University of Paris at the age of 51. He taught anatomy at the college of Tréguier, and later at the University of Paris. He is generally credited with the invention of the use of injection in dissection, but while he taught it evidence points to its being known before he used it. He appears to have been an ardent disciple of Galen rather than an original investigator, but gained a great name in his profession. The Sylvian fissure, the Sylvian aqueduct and the Sylvian artery were named for him.

SYMBIOSIS, a biological term introduced by De Bary to denote intimate and complementary partnerships between different organisms, as between the algoid and fungoid elements in lichens, or between unicellular algæ and radiolarians. A great number and variety of cases of symbiosis have been recorded among the lowest plants, but botanists find the subject more and more obscure and their decisions are by no means general. The effort to differentiate symbiosis from commensalism and parasitism has proved most baffling in many cases. The term «social symbiosis» has been given to the association of insects found in the communities of ants, bees, termites, etc., where many small aphids, beetles, etc., not at all related to their hosts, dwell in peace and in some cases seem to contribute to the general welfare as well as receive benefits. The subject has been discussed mainly in Germany. Consult Brandt in *Archiv für Anatomie und Physiologie* (Leipzig 1882); Hertwig, Oskar, 'Die Symbiosis' (Jena 1883); Keeble, Frederick, 'Plant-Animals: A Study in Symbiosis' (Cambridge 1912).

SYMBOL, a word of various meanings, derived from the Greek word *symbolon,* «a sign,» or *symbole,* a composition. In the early period of Christianity the word was often applied to the Creed and is still so applied in Latin countries. It is also used to indicate, either in a religious or profane sense, an emblem, figure or type, something which specially distinguishes one regarded in a particular character, or as occupying a particular office, or holding a special place in legend or mythology, as, for instance, the trident which is the symbol of Neptune. See SYMBOLS, ASTRONOMICAL; SYMBOLS, CHEMICAL; SYMBOLS, MATHEMATICAL.

SYMBOLIC LOGIC. See LOGIC, SYMBOLIC.

SYMBOLISM. The word symbol is derived indirectly from the Greek *symbolon,* a sign or token. Symbolism is the art and doctrine of symbols; it is the knowledge of the treatment of symbols or of deciphering the occult intent of signs or symbols and especially in reference to things spiritual, invisible or unable to be pictured, as an idea, a quality, etc. To the Greeks the word *symbolon* meant signs of such clearness that the allusion and the object were practically coincident. Among the Greeks their hospitality ended in giving their guests, or exchanging with them, a memorial of the visit in the form of a wooden tablet, a die or a ring, broken into two pieces. The host retained the other half, and in case of a future meeting presentation of the halved token was a sure identification, as one half fitted exactly into the fracture of the other half of the *symbola.* It is claimed by authorities that the origin of symbolism is traceable to the hieroglyphics or pictorial writings of the ancient Egyptians and was transmitted from them to other nations by the Jews. The Egyptians symbolized their gods with animal forms or combinations of both human and animal form; thus Horus, the sun-god, took the form of a sparrow-hawk, the disc was the hieroglyph of the sun, hence the winged disc (*Mir*), derived from the Assyrians, has its clear definition, and expressed also the victory of good over evil. The snake (*uraeus*) was symbol of death, hence, used as an attribute of the Egyptian kings, meant power over capital punishment, just as the handled cross (*ankh*) seen held by gods and kings signified life. The staff (*uas*) was the Nile kings' symbol of authority and has retained that significance with most nations ever since. From insect life also the Egyptians obtained such important symbols as the scarab (*Scarabæus sacer*), the «sacred beetle,» which they worshipped as a symbol of divinity, carving its form on finger rings containing inscriptions to be carried as an amulet. As to the mythology of the ancient Greeks and Romans it is not clear to us whether at first they looked upon their gods as symbolic of the elements of the world surrounding them; certain it is that they embody a very perfect system of the symbolism of Creation. With Uranus, god of the heavens above them, wedded to Gæa, the broad-chested earth, bringing forth Cronus, god of the harvests, and Zeus, the light of heaven, springing forth from the heaven god; with the storm-besieged mountain top of Olympus dedicated as seat of the lightning god and realm of the divine brood, poetic symbolism could get no closer to the human accounting of nature. Contemporary writers appear to show the acceptance of the theogony as allegoric if not symbolic, and symbolism played a big rôle in the mysteries and in orphism. And the Neo-Platonists under Plotinus, Porphyry, Proclus and the Emperor Julian were forced by the ridicule and logic of the Christian apologists to acknowledge that Saturn, Jupiter, Mars, Minerva and Venus were but symbols under which with other myths they represented divine attributes and manifestations. Leaders in the modern schools of learning begin to see that it is symbolism that is expressed in the mythologies of Egypt and India as well as of Greece and Rome. But the most universally practised worship has been that of the sun-god, whose symbol, the swastika, dates back earlier than the Sanscrit, and which symbolic cross has always been a sacred sign and known as the «Wheeling cross» or «wheel of the law» with Buddhists. Representing the sun, when its hands point to the right, on its westward orbit, and symbol of the earth's revolution in easterly direction when the hands point to the left (sometimes then termed suavastika), it is found as an ancient symbol all over the American continent on pottery of our prehistoric races. In a slightly varying form this swastika, known as the *fylfot,* appears among the ancient Celts as a favored symbol, occurring very frequently among the Scandinavian nations of early days. Variables such as the *triskelion, tetraskelion,* etc., are interesting but belong to the subject of symbols, not symbolism now under discussion. The Chinese live in an atmosphere of symbolism, every decoration having symbolic motifs as the chief characteristic, and even the shapes of the vases and jugs are symbolic. Scattered all over their pottery, porcelain, bronzes and enamels we find such symbols as those of longevity: *Kylin* (unicorn), *kwei* (tortoise), *ho* (crane), *luh* (deer). Their mystic number eight (*Pa*) shows forth in the *Pa-pao* or eight «precious things»; the *Pa-kwa* or eight mystic trigrams, the astrologers' symbols; the *Pa-chi-siang* or eight Buddhist symbols, etc. From the vegetable kingdom they find symbolism in the peach (*tao*), token of marriage and longevity, while the latter condition is also symbolized in the gourd (*hu-lu*) and the fungus (*chi*); and the bamboo (*chuh*), pine (*sung*) and plum tree (*mei*) are symbol of three friends. With the Japanese symbolism is a large part of their life. Among such we find: A plum, bamboo, orchid and a chrysanthemum symbolize the «four wise men» of Confucius; a pine twig, wisp of straw and a red lobster are a New Year symbol combination; a moon, snow flake and a flower in conjunction are symbols of the changing conditions of nature.

Jewish Symbolism.— Like all other Oriental peoples the Jews practised their system of symbolism. Many symbolic rules and formulæ occurred in the building of Solomon's Temple, if the result of the researches of the Freemasons can be relied on. The rending of Jeroboam's garment by the prophet Ahijah implied the separation of Israel from Judah; the rainbow presented a sign or symbol of the pact between God and the earth; the law of circumcision was a symbol of the covenant of the body. Josephus writes that the high priest's vestments were in every detail of symbolic intent, the coat symbolizing the earth; the upper garment, heaven; the bells and pomegranates, thunder and lightning; the ephod, the four elements, and the interwoven gold, the glory of God, the 12 jewels in the breastplate, the signs of the zodiac, etc. Other instances of symbolic significance are the blood of the Paschal lamb, the shearing of the hair of the Levites, washing and bathing and anointing as a ritual, the laying on of hands, etc.

Christian Symbolism.— While the primitive Christians in the Roman Empire used a symbolic language of signs, this was not done as a matter of choice but of necessity The persecuted sect could not safely, even in the Catacombs, express themselves in their depictions on sarcophagi or chapel walls with open comment; they had to hide their epitaphs and other written or depicted statements in forms that would not draw down destruction on them. Any originally conceived system of symbolism specially created for giving expression to Christian doctrine would have brought suspicion among the authorities as to the intent of such strange symbols. Therefore we find these early worshippers of the cross using an eagle, Roman symbol of Jupiter; they borrowed from the signs of the zodiac, from symbols appearing in the pantheistic mysteries, etc. And when they, later, used the sign of the cross it was half hidden in combination with an anchor, a symbol used by the pagans. A crude form of a fish (now called a *vesicle* or a *mandorla*) became symbol of Christ referring to a similarity of sound, *ichthus* the Greek word for fish, or from the fact that the letters therein would serve as the Greek initials of the words: Jesus, Christ, Son of God, Savior. The vine (attribute of Bacchus) was adopted as a symbol of Christian promise. The lamb, the palm, the Good Shepherd, would all be understood by the heathen contemporaries in a different sense than that given to these symbols by the early Christians. Greater safety in the use of symbols was afforded the Christians from the fact that there were other persecuted sects within the Roman Empire, who, for their forbidden cults, initiated a well-developed system of symbolism for use in public communications to their fellows, a language undecipherable to the uninitiated. Inscriptions of these symbolic expressions are found cut in the vast rock temples in Egypt, in Syria, Asia Minor, Sicily, Greece, on the Rhine and in France. A method of inculcating a knowledge of this sign language, together with the cult, was carried on unbeknown by their persecutors. They formed themselves into literary societies, guilds, burial unions, schools, etc., all under license as legal corporations, but secretly active as congregations of doctrine propaganda instead of the supposed secular gatherings. Among the systems of symbolism adopted by the early Christians were those belonging to the Pythagorean and Platonic doctrines and the sacred number systems among them. But from 325 A.D. such usage became a state offense. Augustine made war on the symbolic language and declared it a characteristic of the Gnostics. This latter sect, coming into existence when Christianity was first preached openly, endeavored to combine its principles with the Greek philosophy. Under such teachers as Saturninus, Basilides and Valentine a very extensive symbolic language was created in the Byzantine period and practised by these Gnostics, but the full intent of the expressions of this cult is lost to us at this day. Byzantine art discloses a considerable proportion of their symbols, such as the *Abraxas*, etc. As a matter of fact there is a close connection between Byzantine Christianity and Mithraism, from which much was derived, even if in changed form. And Byzantine art is built up entirely of symbolism, even to its very architecture, and its frequent lack of beauty from an artistic point of view is caused by its occultism in form and manners. Unlike the pagans, the Christians in their practice of symbolism always clearly distinguished the conventional signs from the divine and sacred essence they represented in their ceremonies or sacraments. In covering the catacombs with such depicted figures as fish, lamb, shepherd, grapes, fountain and hart, ship sailing safely on rough seas; with their $\overset{P}{X}$ Chi Rho («sacred monogram»), Alpha and Omega, etc., they set up no figures for idolatrous worship, but simple allegorical symbols. Leading authorities on ecclesiastical symbolism were Hugo of Saint Victor, Richard of Saint Victor, Vincent of Beauvais, Durandus, bishop of Mende, Languedoc, Honorius of Autun, Sicardus of Cremona, etc.

Symbolism attained its apogee in the Middle Ages, when animals, colors, plants, lines and attitudes had their hieratic significance. Candles, symbolic of the Light of the World, found ubiquitous use in all rituals; the vestments of the clergy, besides the ritual itself, were symbolic. The Church also had its representation in a woman crowned and majestic, bearing the banner of victory and the chalice, while Judaism, as unbelieving, took the form of an aged woman holding a cracked staff, the tables of the law falling to earth, her eyes bandaged and her crown toppling from off her head. Art was fond of depicting the universality of life's uncertain tenure by illustrating, under the title of «The Dance of Death,» a human skeleton calling, as unwelcome visitor, on king, queen and humble peasant. The books of «Bestiaries» afford us an insight into the allegorical or mystical significance of the most grotesque mythical animal creations of those days of superstitions. They figure on the gargoyles and in the moldings of Romanesque and Gothic structures. Much of the beauty of Gothic architectural traceries is found in the disposition of the trefoil and quatrefoil, having their symbolic intent of the Trinity and the four Evangelists. And the four Evangelists themselves enter the language of symbolism either as the «four rivers,» or Matthew being represented as an angel, Mark as a lion, Luke as a winged ox and John as an eagle. The 12 Apostles were given each their symbol for recognition in art depiction; Saint Peter bearing a key, Saint Jude a cross, Saint Matthew a wallet, Saint Thomas a spear, Saint Simon Zelotes a saw, and so on. Alchemy, from which our science of chemistry arose, was largely a science of mysticism and symbolism. It was probably derived from the Egyptians, not the Arabs as was formerly supposed, and Hermes is, after all, likely to have been the originator. At first the view evidently was that metals in their changeable forms (reactions) had body and soul like human beings, hence lead was called Osiris and considered by the Egyptians as the soul, or «prima materia» of all metals. Later it was supposed that quicksilver (mercury) was the soul of metals. And in the final determining the alchemists (probably through the Babylonians) used the planetary names for the metals thus:

Planet	Symbol	Metal
Saturn	♄	Lead
Jupiter	♃	Tin
Mars	♂	Iron
Sun	☉	Gold
Venus	♀	Copper
Mercury	☿	Quicksilver
Moon	☽	Silver

And from the hermetic books sprang our first knowledge of chemistry, in which the chemical contents wrap up in philosophy and religion the search for gold and the philosopher's stone. And we learn from these students that the stone was «the world in little, microcosm, man: one, a unity; three, mercury, sulphur and salt, or spirit, soul and body.» And we find the alchemists speaking of men as metals and reading such an ancient authority as Isaak Hollandus, it is difficult to differentiate between mankind and lead (which is called Saturn), but we are told by his interpreters that he must not be understood to speak of common lead but the lead of the philosophers. Great symbolists were the Rosicrucians, if we may believe what we read about them. From those who claim the origin and existence of the Rosicrucian fraternity as a probable existence of the past we are informed that the writings, 'Fama' and 'Confessio,' of the early 17th century in mentioning therein the gold which they alchemistically created it was «not the gold of the multitude but it is the living gold, the gold of God.» Symbolism, therefore, pure and simple. And later the brotherhood (in England) under Frizius and Fludd transform the ritual into Freemasonry and its symbolism is stated in the «Summum Bonum.» The Renaissance and Reform arrested the science of symbolism.

The science of heraldry is largely one of symbolism and the numerous crosses have in past days had authorities who deciphered the symbolic intent of their variants, as well as the meaning of many other «charges.» Symbolism has been applied to a language of flowers, as well as to colors, numbers, etc. And each of these fields of application have been more or less adopted by the Christian Church in its symbolism.

The term «symbolism» is used in the technique of psychoanalysis to define a certain brain reflex action, as in dreams, etc. In the science of psychoanalysis there are two spheres or states of the mental process; they are designated the «preconscious» and the «unconscious.» Much of the *unconscious* brain action is what the psychoanalyst terms «archaic,» meaning what is known to the lay world primitive or animal. Symbolism in this teaching has a very broad aspect as is disclosed by such an authority as Wm. A. White in the following expression: «For what after all is a word but a symbol of an idea and an idea but the symbol of a thing.» «Whether or not we see the symbolism of a given expression, for example, depends upon the closeness of analogy between the sign and the thing signified. The closer the analogy the less the symbolism and the less evident the analogy the more pronounced the symbolism.» «Ferenczi uses the term symbol to apply only to likenesses that have one member of the equation repressed in the unconscious.» «The idea symbolizes in mental imagery the thing in the outside world and the word symbolizes the idea. From this point of view our thinking takes place by the use of symbols.» In its action, we are told, the symbolism of a word may assume dynamic force (energy). In such dynamic symbol words are included *flag, patriotism*, etc. This medical conception and theory of symbolism is claimed to be of assistance in indicating the true inwardness of certain neuroses, as hysteria, etc.

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CLEMENT W. COUMBE.

SYMBOLISTS, the name of a group of French writers and their imitators in other countries whose school arose in the eighties and at first was supposed to indicate a reaction against Parnassianism and realism. The school or rather style was inaugurated by Philippe Auguste Mathias Villiers de L'Isle-Adam (1838–89) whose play 'Axël' remains the typical drama of the Symbolists. The Symbolists are so called from their habit of introducing an object or being merely as an expression of an idea. Dreams, mythology, music, are their favorite subjects, which they commonly interpret in lyric verse. Form and expression count more with them than substance. Their characters are often degenerate, their themes repulsive, their wit redolent of the gutter and their notions of art rather subversive of morality than otherwise. They were frequently called Décadents, especially the earlier followers of Baudelaire. Jean Moréas (1856–1910) was at first one of the defenders of the principles of the Symbolists, defending them from the appellation of decadent and justifying their innovations as the natural development of the prosody of Baudelaire, Mallarmé and Verlaine. Later he returned to the older forms of versification and to the classical tradition. Other prominent figures among the Symbolists were Gustave Kahn, Catulle Mendès, De Régnier, the Belgians Mæterlinck and Rodenbach, the Americans Vielé-Griffin and Stuart Merrill, the Irishmen John M. Synge and William Butler Yeats and the Englishman Aubrey Beardsley, whose unwholesome pictorial productions certainly classify him with the Symbolists. The most beneficial innovation of the Symbolists lay in their attempts to break away from the formality and stiffness of French versification in their attempts at rhymed prose or *vers brisés*. They abandoned rhyme and the fixed traditional forms and reveled in assonance, repetition and generally attempted to make their lines the visible counterpart of their themes. (See FRENCH LITERATURE). Consult Barre, André, 'Le Symbolisme' (Paris 1911); Gourmont, Rémy de, 'Le livre des masques: portraits symbolistes, gloses et documents sur les écrivains d'hier et d'aujourd'hui' (2 vols., ib. 1914); Kahn, Gustave, 'Symbolistes et décadents' (ib. 1902); Pellissier, G., 'Etudes de littérature contemporaine' (ib. 1898); Symons, Arthur, 'The Symbolist Movement in Literature' (London 1899).

SYMBOLS, Astronomical, signs or symbols some of them very ancient, which conveniently represent astronomical objects, phases of the moon, etc., and astronomical terms. They are:

SYMBOLS OF THE HEAVENLY BODIES.

Sun	☉	Juno	⚵
Mercury	☿	Vesta	⚶
Venus	♀	Jupiter	♃
Earth	♁ or ⊕	Saturn	♄
Moon	☾	Uranus	⛢ or ♅
Mars	♂	Neptune	♆
Ceres	⚳	Comet	☄
Pallas	⚴	Star	✱

The asteroids, except the four given here, are represented by a circle with a number, thus, (64), designates Angelina, the sixty-fourth asteroid, in order of discovery.

LUNAR PHASES.

● Moon in conjunction, or *new*.

☽ Moon in eastern quadrature, or *first quarter*.

○ Moon in opposition, or *full*.

☾ Moon in western quadrature, or *last quarter*.

SIGNS OF THE ZODIAC.

Aries	♈	Libra	♎
Taurus	♉	Scorpio	♏
Gemini	♊	Sagittarius	♐
Cancer	♋	Capricornus	♑
Leo	♌	Aquarius	♒
Virgo	♍	Pisces	♓

PLANETARY POSITIONS.

Ascending node	☊	Eastern Quadrature E	□
Descending node	☋	West. Quadrature W	□
Conjunction	☌	Trine	△
Sextile	✱	Opposition	☍
Quadrature	□		

ASTRONOMICAL CONTRACTIONS.

Right ascension, R.A. Æ, or a.
Declination, Dec. or δ.
North polar distance, N.P.D.

SYMBOLS, Chemical, letters or symbols used in chemistry to designate the various chemical elements. They are merely the first letters of the names of these elements (not in every case of their English name); or when the names of two or more elements begin with the same letter, two letters are used as the symbol, one of which is always the first letter of the name of the element. Generally speaking the letters comprising the symbol are taken from the English name of the element; but in some instances, specially in the cases of metals which have been long known, the symbols are derived from the Latin names: thus we have *Hg*, symbol for mercury, from the Latin *Hydrargyrum; Fe*, from the Latin *Ferrum*, for iron; and so on. In a few cases the symbols are deduced from the old German names: thus *K*, the symbol for potassium, is the first letter of the old German word *Kalium*, and *Na*, the symbol for sodium, is from the German *Natrium*. However derived, whether from English, German, Latin or French, the symbols of the chemical elements are universally the same. For a considerable time French chemists employed the symbol *Az* to represent nitrogen, from the name *Azote*, which was given to this element in reference to the fact that it alone could not support life (Greek, *a*, privative, and *zoē*, life); but this symbol is now almost entirely superseded by the letter N. The symbols of chemical compounds are constructed by placing together the symbols of their constituent elements, a number being attached to each signifying how many atoms of the element enter into the composition of the amount of the compound expressed by the entire symbol. For it must be understood that chemical symbols have a quantitative as well as a qualitative meaning. When a chemist meets in a chemical treatise with the symbol *O* he knows that this signifies not only oxygen but a certain definite amount by weight of oxygen, *O* always means 16 parts by weight of oxygen, so *Fe* means 56 parts by weight of iron; and so also the compound symbol Fe_2O_3 means $(56 \times 2) + (16 \times 3) = 160$ parts by weight of oxide of iron. For a further account of the uses and modes of formation of chemical symbols see the article CHEMISTRY.

SYMBOLS, Mathematical, signs or abbreviations used in mathematical operations for the sake of brevity and to facilitate expression. In arithmetic and algebra there are four general kinds of symbols used; namely, those of quantity, operation, relation and abbreviation. Quantities are generally represented by letters. Known quantities are represented by the leading letters of the alphabet, or by the final letters with one or more accents, thus: x', x''', y'', etc. Unknown quantities are represented by the final letters of the alphabet, as x, y, z, etc. Besides the English letters, those of the Greek alphabet are often made use of. Certain letters have come to represent certain quantities. Thus, π generally stands for the ratio of the diameter to the circumference of circle, or the number 3.1416; e denotes the base of the Naperian system of logarithms, or the number 2.718281828; M denotes the modulus of any system of logarithms. The symbol ∞ denotes an infinitely great quantity.

Of the symbols of operation the sign +, *plus*, when written between two quantities, signifies that the second is to be added to the first; as, $a + b$. The sign —, *minus*, when placed between two quantities, denotes that the one on the right is to be subtracted from the one on the left; as, $a - b$. The sign ×, when placed between two quantities, denotes that the one on the left is to be multiplied by the one on the right; as, $a \times b$. Multiplication may be indicated by placing a point between the factors when they are both expressed by letters; as, $a.b$. This method is not applicable when the factors are numbers, because, in that case the indicated product would be confounded with a mixed decimal fraction; thus, 5.6, instead of being read, product of 5 by 6, would be read 5 and 6-tenths. There are cases, however, where the sign is used between numerical factors, as in series where the factors follow a law which it is desirable to keep before the eye: thus the general term of the binomial formula is

$$\frac{m\cdot(m-1)\cdot(m-2)\ .\ .\ .\ (m-n+1)}{1\cdot 2\cdot 3\cdot 4\ .\ .\ .\ .\ .\ n}\, a^n x^{m-n}\ .$$

The sign ÷, placed between two quantities, indicates that the one on the left is to be divided by the one on the right; as, $a \div b$. Division may also be indicated by writing the quantities in place of the points; as, $\frac{a}{b}$, or $a:b$, or a/b, $\underline{a|b}$ . . . . $x^{-n} = \frac{1}{x^n}$. The sign ~ denotes the difference between two quantities, without implying which is to be subtracted from the other; as, $a \sim b$. The sign $\sqrt{\ }$ is called the radical or evolution sign, and when placed over a quantity indicates that its root is to be taken; as, $\sqrt{a}$: the degree of the root is indicated by a number written over the sign, which is called the index of the *root* or *radical;* thus $\sqrt[3]{a}$, $\sqrt[4]{a}$, etc. The sign $\sqrt{\ }$ indicates the square root. A vinculum —, bar |, brackets [], { }, parenthesis (), etc., indicate that the quantities enclosed by them are to be regarded together; as, $(a+b)\,x$, $\left.\begin{matrix}a\\+b\end{matrix}\right|x$, etc. The symbol Σ denotes that the algebraic sum of several quantities of the same nature as that to which the symbol is prefixed is to be taken, thus,

$$\sum \frac{q}{n(n+p)} = \frac{1}{p}\left[\,\Sigma\left(\frac{q}{n}\right) - \Sigma\left(\frac{q}{n+p}\right)\right]$$

is a formula, in which p being constant and q and n arbitrary, signifies that of the algebraic sum of any number of terms deduced by attributing values to q and n is equal to $\frac{1}{p}$ multiplied by the difference of the algebraic sum of the terms, which are deduced by attributing the same values to q and n in the expressions $\frac{q}{n}$ and $\frac{q}{n+p}$. Of the symbols of relation f, F, ϕ, written before any quantity, or quantities, separated by commas, as $F(x)$, $f(x, y)$, $\phi\ (x, y, z)$, etc., denotes quantities depending upon the quantity or quantities within the parenthesis, without designating the nature of the relation. The sign of equality, $=$, between two quantities, denotes that those quantities are equal to each other. The sign of inequality, $>$, placed between two quantities, denotes that the one placed at the opening of the sign is greater than the one placed at the vertex of the sign; thus, $a > b$, a is greater than b, but $a < b$, is read: a is less than b; also, $a \not> b$, a is not greater than b; $a \not< b$, a is not less than b. The sign $\neq$ is a negation of equality; as, $a \neq b$, a is *not* equal to b. The signs of proportion :, : :, :, placed between quantities, taken two and two, show that the quantities are in proportion; thus, $a : b :: c : d$, is read, a is to b as c is to d. The first and third signs are signs of ratio, and the second the sign of equality, so that the above might be written

$$\frac{b}{a} = \frac{d}{c}.$$

Of the symbols of abbreviation the sign $\therefore$ stands for *therefore* or *hence* and $\because$ stands for *since* or *because.* Other algebraic and mathematical symbols are % for *per cent* or ‰ *per thousand;* $\int$ the symbol of integration; the Decimal, as in 5.6 (America), 5·6 (Great Britain), 5,6 (Continental Europe), meaning 5 and 6-tenths; identity $\equiv$.

Geometry borrows most of its symbols from those of algebra just explained. Magnitudes are represented pictorially; the symbols $\angle$, $\measuredangle$ are pictorial representations of *angle, angles.* $\parallel$ means *parallel to;* $\perp$ *perpendicular to;* $\triangle$, ▲, represent pictorially the terms *triangle* and *triangles* respectively; while ⊙, Ⓢ, represent *circle, circles;* □, ▣, *square, squares;* ▭, ▣, *rectangle, rectangles;* and ▱, ▱., represent *parallelogram* and *parallelograms.* Arc is represented by the symbol ⌒ and $\acute{a}$ designates radians; $\sim$ means *congruent to* and $\sim$ *similar to.* See NOTATION and consult Cantor, M. B., 'Vorlesungen über Geschichte Mathematik' (Leipzig 1910); 'Vorschläge zur Vereinheitlichtung der Mathematischen in Schilunterricht,' in 'Schiften des deutschen Ausschusses für den mathematischen und naturwissenchaftlichen Unterricht' (ib. 1913). This contains an extended list of symbols.

SYME, sīm, **James,** Scottish surgeon: b. Edinburgh, 7 Nov. 1799; d. 26 June 1870. He was educated at the university of his native city, and studied anatomy under Barclay and Liston, visiting also Paris and Germany. In 1829 he opened Minto House Hospital, which he carried on for four years with great success as a surgical charity and school of clinical instruction; and in 1833 was appointed professor of clinical surgery in Edinburgh University. In 1847, on Liston's death, he accepted the same professorship in University College, London; he soon, however, returned to his former chair in Edinburgh, and continued to hold it till his death. Among his numerous writings are a 'Treatise on the Excision of Diseased Joints'; 'Principles of Surgery'; 'Diseases of the Rectum' (1838); 'Pathology and Practice of Surgery' (1848); 'Stricture of the Urethra' (1849). Consult Paterson, R., 'Memorials of the Life of James Syme' (Edinburgh 1874).

SYMEONIS («SIMMONS»), **Henry,** the hero of the most persistent and unique feud in history: Oxford University having for nearly 600 years (till 1827) required every candidate for the baccalaureate to swear war, not even against Symeonis' posterity, but against allowing himself, centuries dead, to be «reconciled.» The only explanation hitherto given in a cyclopædia is an incredibly silly guess of Brian Twyne in 1608, that Symeon had feigned baccalaureacy before attaining it. Such a trifle would never have gibbeted him for the ages. In fact, the cause was precisely his not being a student at all. He was a wealthy citizen of Oxford, who about 1242, in the first historic «town and gown row,» killed a student and fled into exile from the vengeance of the others. Against their protest Henry III allowed him to compound for £80 (some $5,000 now) and return to stand trial. The university seems to have fought this off for nearly 20 years; and when overborne in 1264, they made this at least one grievance for most of them removing to Northhampton. Simon de Montfort on mastering the king in that year recalled them; presumably, therefore, Symeonis' permit was rescinded. At all events, the university exacted an oath from all degree men thereafter not to consent to his «reconciliation» — that is, peaceable residence in their town. It was retained after his death *in terrorem,* as a warning to all who might molest Oxford students; and at last mummied as part of a set of historic victories not to be canceled, though this one was long forgotten.

SYMINGTON, William, British engineer and inventor: b. Leadhills, Scotland, 1763; d. London, 22 March 1831. He was educated at the universities of Edinburgh and Glasgow, studying for the ministry, but abandoned that profession to become a civil engineer. In 1787 he took out a patent for an improved form of steam-engine, and in 1802, after years of futile attempts, he succeeded in propelling the tug-boat *Charlotte Dundas* by means of steam-engines with which he had fitted her. He gained the patronage of the Duke of Bridgewater, but the death of the duke in 1803 left him without the financial aid necessary to the promotion of his venture, and being unable to gain it elsewhere, he drifted from place to place, finally dying in poverty.

SYMMACHUS, Pope (498–514): b. Cardinia (?); d. Rome, 19 July 514. He was baptized at Rome, entered the ranks of the clergy and was ordained deacon. He was elected and consecrated Pope 22 Nov. 498, succeeding Pope Anastasius II. However, a minority of the Church, of Byzantine learnings, met on the same day and elected the Roman archpresbyter Laurentius as Pope, and a bitter dispute ensued. The matter was carried to Theodoric, the Gothic ruler of Italy, who decided in favor of Symmachus as having been elected first and by a majority. The Byzantian party, persisted in its efforts to seat Laurentius, established him in Rome and gained control of severr churches. It brought various charges against Symmachus, but after many sittings and much controversy the Synod reached the momentcus decision that the Pope is above temporal authority. In 505 or 506 Theodoric ordered Laurentius to surrender the churches held by him and his followers and the dispute came to an end. The remainder of Symmachus' reign was uneventful, except in the way of quiet progress. He formulated rules for the sale of Church property which were of great benefit to the Church; and his name is connected with the building or decoration of various churches in Rome.

SYMMACHUS, sĭm'ą-kŭs, **Quintus Aurelius**, Roman statesman of the 4th century. He was educated in Gaul; and after serving as quæstor and prætor became corrector of Lucania and Brutii (365) and proconsul of Africa (373) and member of the pontifical college. His petition to Gratian, urged on the Senate's behalf, for the restoration of the altar of Victory, proved unavailing (382), as did the extant letter addressed by him when præfect of the city (384) to Valentinian. The failure led him to side with the pretender Maximus (387), and for so doing he was impeached of treason, but pardoned and raised to the consulship (391). There remains of his works 10 books of letters and fragments of orations. These are contained in Seeck, ‘Monumenta Germaniæ Historica: Auctores Antiquiesini’ (Vol. VI, Berlin 1883). Consult Dill, S., ‘Roman Society’ (London 1899); Dimsdale, M. S., ‘History of Latin Literature’ (New York 1915).

SYMMES, sĭmz, **John Cleves**, American soldier and author: b. Sussex County, N. J., about 1780; d. 1829. In 1802 he entered the United States army as ensign and served through the War of 1812, reaching the rank of captain in 1813. At Niagara and the Fort Erie sortie he won distinction. After the war he lived at Newport, Ky., and passed his time in propounding his own planetary theory, which comprised the belief that planetary bodies, including the earth, consist of hollow concentric spheres open at their poles. The inside of the earth he believed to be inhabited, and he imagined an aperture (known since as “Symmes' Hole”) in the earth's crust, near latitude 82° N., communicating with the interior of the planet, where he fancied plant and animal life to exist, and which he described as being lighted with two subterranean suns, Pluto and Proserpine. Humboldt stated that he and Davy had repeatedly been invited by Symmes to descend through this hole to the earth's interior. In 1822 and in 1823 Symmes petitioned Congress for an expedition to test his theory. Jules Verne is said to have made this idea the basis for his story, ‘A Journey to the Centre of the Earth.’ Symmes advocated his views in lectures and pamphlets, and in a work entitled ‘Theory of Concentric Spheres’ (1826). Consult *Atlantic Monthly* (April 1873, ‘Symmes' Theory of the Earth’).

SYMMES' HOLE. See SYMMES, JOHN CLEVES.

SYMMETRY. From the Latin *symmetria*; proportion, symmetry; which, in turn was derived from the Greek *symmetria*, meaning agreement in dimensions, proportionate. In its present-day intent the word symmetry in the language of the laity can be defined as harmony or balance in the proportions of parts as to the whole.

Geometry.— Two points are said to be symmetrical with respect to a straight line, when the straight line bisects at right angles the straight line joining the two points. Thus in Fig. 1 the two points P and P' are symmetrical with respect to the line $M\ N$, if $M\ N$ bisects $P\ P'$ at right angles. In such a case the line $M\ N$ is termed the *axis of symmetry*. Two figures are said to be symmetrical with respect to an axis when every point in one figure has its symmetrical point in the other. Thus in Fig. 2 the figures $A\ B\ C$, $A'\ B'\ C'$

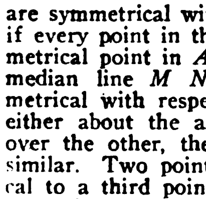

FIG. 1.

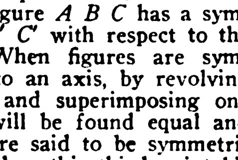

FIG. 2.

are symmetrical with respect to the axis $M\ N$, if every point in the figure $A\ B\ C$ has a symmetrical point in $A'\ B'\ C'$ with respect to the median line $M\ N$. When figures are symmetrical with respect to an axis, by revolving either about the axis and superimposing one over the other, they will be found equal and similar. Two points are said to be symmetrical to a third point, when this third point bisects the straight line joining the two points. Thus in Fig. 3, P and P' are symmetrical with respect to A, if the straight line $P\ P'$ is bisected at A. And the point A is called *the* *centre of symmetry*. Two figures are said to be symmetrical with respect to a centre, when as in Fig. 4, the triangles $A\ B\ C$, $A'\ B'\ C'$ are

FIG. 3.

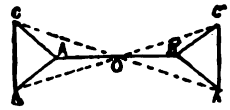

FIG. 4.

symmetrical to the centre O, and every point in the triangle $A\ B\ C$ has a symmetrical point in $A'\ B'\ C'$. A figure is symmetrical with respect to an axis when it can be divided by that axis into two figures symmetrical with respect to the axis. And a figure is said to be symmetrical with respect to a centre when every straight line drawn through that centre cuts the figure in two points symmetrical with respect to this centre. In solid geometry when two planes intersect they are said to form a *diedral angle*. When three or more planes meet in a common point, they are said to form a *polyedral angle* at that point. Two polyedral angles are symmetrical, when the face and diedral angles of one are equal to the face and diedral angles of the other each to each, but arranged in *reverse order*. As example the triedral angles $S\ A\ B\ C$ and $S'\ A'\ B'\ C'$ (in Fig 5) are symmetrical when the face-angles

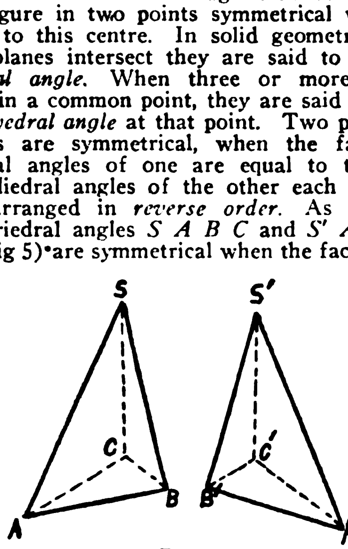

FIG. 5.

$A\ S\ B$, $B\ S\ C$, $C\ S\ A$ are equal respectively to the face angles $A'\ S'\ B'$, $B'\ S'\ C'$, $C'\ S'\ A'$ and the diedral angles $S\ A$, $S\ B$, $S\ C$ to the diedral angles $S'\ A'$, $S'\ B'$, $S'\ C'$.

Symmetrical spherical triangles are those in which the sides and angles of the one are equal respectively to the sides and angles of the other, but arranged in the reverse order. Thus the spherical triangles $A\ B\ C$ and $A'\ B'\ C'$ (Fig. 6) are symmetrical when the vertices of

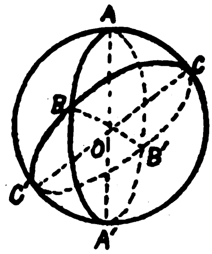

FIG. 6.

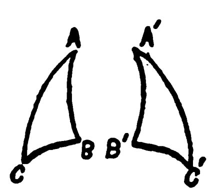

FIG. 7.

the one are at the ends of the diameters from the vertices of the other (antipodal). Two symmetrical triangles are mutually equilateral and equiangular; yet in general they cannot be made to coincide.

In algebra «a function of several quantities which is not changed when any two of the quantities are interchanged, such as Σa, a_2, is called a symmetric function of the quantities. Such a function of the roots of the equation has been designated by enclosing the exponents in brackets, expressing the repetition of a number by an exponent: thus Σa^3, $a^3_2 a^3_3 a_4 a_6 — a6$ is written $[3^2 2\ 1^3]$. In particular, a symmetric function of the form $[K] = a^{k_1} + a^{k_2} + \ldots . a^{k_n}$ is called an elementary function» (Decker).

Physiology.— In the science of biology animals are distinguished as *Radially* symmetrical; *bilaterally* symmetrical; *serially* symmetrical; *assymmetrical*. This is a division according to their structure internally and externally. In a *radially* symmetrical animal such as a jelly-fish, the body can be halved by a number of vertical planes — it is symmetrical around the median vertical axis. In other words it is of the same conformation all round possessing neither right or left side. In a *bilaterally* symmetrical body, such as that of the human, it is possible to equally divide the body in halves through one plane only. In some animals the body is marked off in transverse grooves creating a series of similar parts like the joints of the human finger or of the bamboo. This is a process termed in biology *metamerism* or *serial symmetry*, closely associated with the worm family. Biologists teach the theory that the evolution of these different symmetrical functions are in accordance with the proportionate inertia or energy inherent in the different animals. Thus in the simple sponges, *Cœlentera* (see SEA-ANEMONES; JELLYFISH), and in the *Echinoderms* (sea-urchins, etc.), we find radial symmetry, also it is characteristic of the very common embryonic stage known as the *gastrula* (an oval or thimble-shaped sac which constitutes two layers of cells). Thus radial symmetry belongs to the sedentary animal life, the life without motive energy, often floating and drifting. Whereas the animals of bilateral symmetry have the advantages of mobile activity in the search for food, as well as power of escape from their enemies by energetic motion in definite directions. In plant life we also find symmetrical qualities in the organism but only rarely in the strict sense as in animal life. It approaches the true condition most nearly in many flowers, leaves and stems with decussating whorls. Two, three, four or a large number of symmetrically dividing planes often pass through one member, as a shoot or root, all of which intersect in the axis of growth. These members are termed *polysymmetrical*. The characteristic is found in the so-called «regular flowers,» in stems with alternating whorls and in most roots. Ferns, etc., can be divided bilaterally. showing a repetition of similar parts on either side, but the symmetry is not exact.

Mineralogy.— One of the most important branches of the science of mineralogy is crystallography which deals with the angular construction of crystals. The *faces* or outer surfaces of crystals are arranged according to certain laws of symmetry and, based on these natural laws of symmetry, crystals are divided into groups and systems. As in geometry, the relationships of the planes to one another are brought under the heads of the *plane of symmetry;* the *axis of symmetry* and the *centre of symmetry.* All may be combined in the same crystal, some have neither characteristic. Study of the conditions has brought the conclusion that there are 32 natural groups among crystals based upon their symmetry. As to *planes of symmetry* in crystals, these occur when for each face, edge or solid angle there is another similar face, edge or angle which has a like position with reference to this plane. Thus in a crystal of amphibole it is symmetrical with reference to a central plane of symmetry and, in ideal cases, it is called the *right symmetry,* having for every point on one side of the plane of symmetry its corresponding point at equal distance on the other side. Each half is a *mirror image* of the other half. In some crystals may be found as many as nine planes of symmetry, three of one set and six of another; this is exhibited in the cube. As to *axes of symmetry,* these occur in crystals when, as in geometry, a solid can be revolved through a certain number of degrees about some line as an axis and, as a result, it again occupies precisely the same position in space as at first. There are four different kinds of axes of symmetry in crystals, each defined according to the degrees in angular revolution needed, in other words according to the number of times the crystal repeats itself in a complete revolution of 360°. Thus the axes are *binary, trigonal, tetragonal,* etc. As to the *centre of symmetry,* most crystals have besides planes and axes of symmetry or without either, a symmetry with reference to a point, its *centre,* as in the triclinic crystal in which every face, edge and solid angle in one half has a face, edge and solid angle in the other half. In such crystal form the geometrical conditions are termed *compound symmetry* with reference to an axis of binary symmetry and a plane normal to it, if the crystal is calculated as divided into two similar halves by a plane parallel to any one of its faces and one half be revolved 180° about an axis normal to this face. Crystals are said to exhibit *pseudo-symmetry* when their angles apparently approximate in symmetry to the requirements of a system higher in symmetry than that to which in fact they belong. The micas show this tendency, being truly monoclinic in crystallization yet in angle appearing, at times, rhombohedral or orthorhombic. Grouping crystals according to their symmetrical forms crystallography creates the following divisions: Isometric system; tetragonal system, hexagonal system, orthorhombic system, monoclinic system and triclinic system. See CRYSTALLOGRAPHY.

Symmetry in Art.— In this subject, as in all art matters, we have to go back to the classic Greeks, from whom, as we have seen, the word symmetry itself is derived. And in art circles for numerous generations the term has been the subject of much controversy, hence, according to the evidence introduced and the strength of the theory advanced, the intent of the word among art experts has changed from period to period. As Viollet-le-Duc says, it used to mean "precise relation between the measurements, harmony, moderated relations, calculated, in view of resulting satisfaction for the mind and eyes. . . . Symmetry to-day says, in the language of architects, not a ponderation, harmonious relations of the parts of a whole, but a similitude of the opposed parts, the exact reproduction on the right side of an axis of that on the left." The Roman architect Vitruvius (1st century A.D.) wrote: "As to symmetry it is a proper accord of the members, of works among one another, and of separated parts, the relation of each of the parts with the whole, . . ." Vitruvius defines the Greek *symmetros* as "qualitas eurythmiae." But eurythmy means harmony, just proportion, more precisely "correct rhythm." This is the Greek sense of the word *symmetria,* but the great superiority of Greek over all other art has been claimed to be the artists' subjection to symmetry through the *modulus* used as a yard-stick. No doubt, both in their architecture and sculpture, the Greeks had a *system,* for comparative measurements absolutely prove this, but, as Viollet-le-Duc claims, the Greeks had no idea of symmetry as "a kind of decalcomania or counterpart"; theirs was altogether a different idea. It was "a harmony of measures, and not a similitude or repetition of parts." Their symmetry was "a relation between established measurements and adopted rhythm." In architecture of great public edifices in which the Greek classic orders figure there is generally a *centre of symmetry* found, as in a bisection from the apex of the pediment of the temple forms, or an axis of symmetry revolvable around the centre of the boss above the roof of the choragic monument of Lysikrates, etc. The decorative features must, therefore, in harmony follow the similar restricted spaces framed in the right and left ends by the angles of the pediment, by opposed recumbent figures or other triangular designs. But these Attic artists and sculptors showed a freedom from mathematical preciseness that pleases and rests the eye while leaving an appearance of the closest exactitude to measure. Treated from the æsthetic viewpoint, symmetry of geometric accuracy in art palls on the senses and, with our modern love of freedom and revulsion against restrictions, we find the periods in art fluctuating from the stern lines of classic masters and taking flights into fantastic opposed methods as in the case of the rococo style or the baroque orgy of unfettered freedom and degraded license and symmetry thrown to the winds. Symmetry is imposed on the designer of wall papers; landscapes (at times), and gardens to this day show tendencies to symmetry imitative of Dutch method of treatment of past days. And in interior decorative and furniture arrangement we find the idea of symmetry prevalent, chairs and other seats as well as mantle ornaments being in *sets.* Lovers of untrammeled art look to the Far East, and especially Japan, for the breach from symmetry in art. There we find symmetrical arrangement, outside of that necessitated in architecture, altogether absent. In the realm of Occidental painting we find the great masters freely grouping their personages in genre work, though in religious work the main figure (we had almost said the *central* figure) is liable to appear in the rather exact middle point, and the surrounding figures are apt to be divided about equally on either side, giving symmetrical balance, probably a habit formed through the many years in which such depiction was *arranged* to cover spaces in churches. To sum up, symmetry would seem to have a dubious place in art, outside of architecture, according to recent ideas. The asymmetric art methods of the Japanese have produced a powerful reaction in our Western æsthetic tastes and the severities of geometric proportion in art design have lost their hold on the minds of this century's artists and patrons. The conception that symmetric balance smacks of *patterns* quite popularly prevails and recent schools are revolutionary in accord with the times.

CLEMENT W. COUMBE.

SYMONDS, sĭm'ŏndz or sī'mŏndz, **E. M.** (GEORGE PASTON), English novelist. She has published 'A Modern Amazon' (1894); 'A Study in Prejudices' (1895); 'The Career of Candida' (1896); 'A Fair Deceiver' (1897); 'A Writer of Books' (1898); 'Little Memoirs of the 19th Century' (1902); 'Sidelights on the Georgian Period' (1902); 'George Romney' (1903); 'The Pharisee's Wife' (play, 1904); 'R. R. Haydon and his friends' (1905); 'Clothes and the Woman' (play, 1907); 'Lady Mary Wortley Montagu and Her Times' (1909); 'The Pope: His Life and Times' (1909); 'The Naked Truths' (play, 1910); 'Nobody's Daughter' (play, 1910).

SYMONDS, John Addington, English author and critic: b. Bristol, 5 Oct. 1840; d. Rome, 19 April 1893. Graduated from Balliol College, Oxford, in 1860, he was elected Fellow of Magdalen in 1862, undertook but abandoned legal studies, and entered literature as a profession. For many years he was compelled by ill-health to reside at Davos-Platz, canton of the Grisons, Switzerland. His studies were largely concerned with the Renaissance and the representative personages of that period. His chief work is the 'Renaissance in Italy' (1875–86), a historical narrative with mingled criticism. Its scholarship is very accurate and comprehensive, and its insight into the spirit of the time and movement is notably acute. If it fail in well-roundedness and system some excuse may be found in the complexity of the subject and some reparation in the brilliancy of individual passages. Other volumes in this general field are 'An Introduction to the Study of Dante' (1872); 'Shakespere's Predecessors in the English Drama' (1884), an excellent contribution to the history of English literature; lives of Sidney (1887) and Jonson (1887) in the 'English Men of Letters' series; of Michelangelo (1893) and Boccaccio (1895); and English renderings of the 'Sonnets of Michelangelo and Campanella' (1878) and the 'Autobiography of Benvenuto Cellini' (1888). Others of Symonds' works are 'Studies of the Greek Poets' (1873–76), designed for the popular reader and approaching Hellenic literature through the individuality of the authors; 'Sketches in Italy and Greece' (1874); 'Sketches and Studies in Italy' (1879); 'Essays, Speculative and Suggestive' (1890); 'In the Key of Blue,' essays (1893); 'Walt Whitman' (1893); and three books of verse, 'Many Moods' (1878); 'New and Old' (1880), and 'Vagabunduli Libellus,' a collection of sonnets (1885). Symonds' critical work is marked by a finished style and a distinctive note of liberal culture. Consult the 'Life' prepared from correspondence by H. F. Brown (1895); Herbert Warren in Miles' 'Poets and Poetry of the Century'; Brooks, V., 'J. A. Symonds: A Biographical Study' (New York 1914).

SYMONS, sĭm'ŏnz, **Arthur,** English poet and critic: b. Milford Haven, Wales, 28 Feb. 1865. He has written 'Introduction to the Study of Browning' (1886); 'Days and Nights' (1888); 'Silhouettes' (1892); 'London Nights' (1895); 'Studies in Two Literatures' (1897); 'The Symbolist Movement in Literature' (1899); 'Collected Poems' (1901); 'Cities of Italy' (1907); 'The Romantic Movement in English Poetry' (1909); 'Knave of Hearts' (1913); 'Figures of Several Centuries' (1915); 'Tragedies' (1916); 'Tristan and Iseult' (1917). He has edited the essays of Leigh Hunt, the plays of Shakespeare, etc.

SYMONS, George Gardner, American artist: b. Chicago, 1865. He received early training at the Art Institute, Chicago, and at Paris, Munich and London. His work was awarded numerous medals and prizes, and he was elected National Academician in 1914. He is represented by 'The Opalescent River' in the Metropolitan Museum, New York City, 'Sorrow' in the Cincinnati Museum, 'Snow Clouds' in the Corcoran Gallery, Washington, and 'The Winter Sun' in the Art Institute, Chicago.

SYMPATHETIC STRIKE. See STRIKES AND LOCKOUTS.

SYMPATHY, is in itself feeling felt, and became possible only after human reason began its operations. As feeling, its discussion belongs to psychology; as a sociogenetic power, its consideration is sociological; as a "motive principle of judgment" (Höffding), it is the concern of the moralist. In any article such as this, it is almost unavoidable to discuss the subject, without at one and the same time involving all three approaches to the consideration of the meaning of sympathy; and here no attempt will be made to avoid such a union. As feeling, sympathy is a secondary, it is a representative pain. It is an echo in one's self of the pains of others. Hedonism of all forms misconceives the relation that obtains between pleasure and pain as being analogous with that which obtains between heat and cold; and indeed in some respects pain and pleasure are counter-parts. But they are not like heat and cold in so far as the one is not the same as the other, differing only in degree. There obtains here a difference which is one of a kind, not merely of degree.

That sympathetic pain depends for its possibility upon the human rational powers admits of no doubt. For the syllogism of sympathy is this: (a) A given influence produces pain or pleasure in me. (b) You are like me. (c) Therefore, the same influence will produce pain or pleasure in you. True, this reasoning in and of itself, is feelingless. But to constitute a motive to activity, such as sympathy developed into altruism may exhibit, there must be first developed a reflex responsiveness, such that previously experienced sensations of pain or of pleasure caused by one influence shall be remembered and revived, shall be repeated as part of a series of sensations that are caused by the influence itself.

It might be an idle speculation to attempt to ascertain the very earliest form of sympathy. However, one may feel certain that it is the reverse of Herbert Spencer's idea which is that sympathy grew out of «love of the helpless.» It is, however, quite probable that «love of the helpless» was one of the earliest manifestations of sympathy, just as light sometimes is evidence of electricity. Perhaps sympathy was first felt in the heart of woman as mother with her strong motive love for her offspring, which natural love, though in itself an entirely different faculty, early enough blended with or helped to create a derivative reason-born sympathy. Altruism differs from sympathy in another way. Sympathy is not necessarily a desire. It is simply a feeling, even though a feeling depending on the rational process, for its existence. True: it naturally enough suggests action. But being a pain, like other pains that are *not desires*, it naturally but not necessarily gives rise to a desire to act in such a way as to cause relief from pain. As such it is the concern of the sociologist. And as said before, it involves an intellectual operation, a knowledge of how one should act to attain an end. Altruism is complex, it is sympathy to which is added desire for activity. It is not only painful feeling, it is also motive. David Hume treated the passions as an essential part of «human nature,» making much of sympathy, as was likewise done both by Ferguson and Adam Smith, later by Bentham, and in more recent times by Professor Höffding, each from his own special point of view. Not a few ethical students conceive of sympathy as the parent of most all the moral sentiments; and sympathy is then in turn derived from love of kindred. Sympathy has it seems its seat in the general emotional tracts, in the great sympathetic plexuses, of which there are so many, and of such very wide distribution in the human system. It is, however, as yet impossible to locate these plexuses, and assign to them particular sentiments — a localization which of course assumes the hypothesis that the system has attained a sufficient degree of specialization to localize sentiment at all. Altruism, in so far as it is not purely biological, is without doubt rooted in sympathy. This latter, as has often been noted, is not seldom conceived in its turn as the bases of all morality excepting race morality. One may well believe that without sympathy all moral reform would be impossible. Just as «Love of the helpless» can only be experienced by a highly rational being, so its root (not its blossom), which is sympathy, is a product of a high rational power of intellectual activity capable not only of representing to self the painful states of others, but also of experiencing the reflex of such representations in one's self as a form of pain. For it requires a power of putting one's self in the situation of another, to represent to one's self the pains of others. When once such power is acquired, it causes a reflex of the represented pain to self and this reflected pain felt by one representing it becomes more and more sharp and unendurable as the representation becomes more vivid, and as the general organization of a human being becomes more delicate and more refined. Such high degree of differentiation was, one may be sure, far from being attained at an early stage of human development, a fact, which, it may be mentioned, explains such vicious and abnormal institutions as the savage subjection of women. Civilization has been, and may indeed be, measured by the capacity of men for suffering representative pain or sympathy and by their efforts to relieve it. For in the merely animal kingdom it may be suspected that there is scarcely any, if there is any, sympathy with suffering at all. And yet as the fine painting by Landseer of a «Sick Monkey» illustrates, one may well hesitate to pronounce that feelings of sympathy are entirely alien to the animal world.

SYMPHONY, an elaborate musical composition for a full orchestra, consisting usually, like the sonata, of three or four contrasted yet inwardly related movements, as an andante followed by an allegro, another andante varied or an adagio, a minuet with its trio or a scherzo, the whole composition closing with a lively rondo or rapid finale. The symphony, which may be regarded as the highest kind of musical composition, was unknown in its present form before the time of Haydn, who with Mozart, Mendelssohn and Beethoven are the most successful composers of this class of compositions. The nine symphonies of the latter are generally recognized as being the noblest works of their kind. The term symphony is also frequently applied to short introductory or closing instrumental passages in compositions which are predominantly vocal. See MUSIC; ORCHESTRA.

SYMPIESOMETER, a kind of barometer in which the weight of the air is indicated by the compression of gas in a tube, the lower part of the tube being filled with some oily fluid and the gas occupying the upper portion.

SYMPOSIUM, The. In the 'Symposium' Plato tells the story (in the main fictitious, no doubt) of a banquet given by Agathon in celebration of a tragic victory on the stage. Instead of the usual diversions over their cups the guests propose to entertain themselves with successive encomiums of Eros, the god of love; and of these speeches is formed the bulk of the dialogue. The most notable of the earlier discourses is that put into the mouth of Aristophanes, the comedian, in which occurs the humorous myth (not without deep significance) of the creation of man as a rounded whole, with four arms, four legs, etc., and of his slicing afterward by Zeus into two half-beings, male and female, who are driven by love to endeavor to reunite themselves once again into a perfect whole. When called upon last, Socrates, with his customary irony, protests his ignorance, but consents to regale the company with a tale he pretends to have heard from a certain wise woman of Mantinea. According to this prophetess, Eros is the offspring of the god Poros («Plenty») and the mortal Penia («Poverty»); he is thus not properly a god, but a mighty daemon, or intermediary being, whose office it is to form a link between the eternal bounty of heaven and the conscious imperfection of mankind. Love, the allegory would say, is not the happiness of possession — for such happiness belongs only to the gods — but the unsatiated longing to possess. By its creative power it is man's substitute for immortality; for if the individual must perish, yet he is permitted by love to continue his existence in his children. It is the source of art, leading men to satisfy by the creation of beautiful forms their innate longing for the absolute beauty they can never possess. It is also the cause of philosophy. He is not a philosopher, but a god, who knows the truth; nor is he a philosopher who is unaware of his ignorance; rather, the philosopher is he, who, being aware of his ignorance, is driven on ever by the soul's thirst for the truth, to learn and to raise his life into one continual communion with the world of ideas. Whether later in date of composition or not, the 'Symposium' is logically a sequel to the mythological portions of the 'Phædrus.' In the earlier dialogue Socrates tells how in some remote age the soul of man, in its winged chariot, followed the procession of the gods to the summit of the celestial vault, and from there beheld the everlasting ideas of truth and justice and beauty and the like, of which things true and just and beautiful in this world are the shadowy transient images. And so, when a man sees some fair object or person, love is awakened in his soul as a reminiscence of that half-forgotten vision. In the 'Symposium' the mythical nature of love as a reminiscence is less emphasized, but its dynamic and philosophic function is developed in splendid imagery. Without this emotional quality, as it is worked out here and as it is suggested in other dialogues, the ideas of Plato would be a curious theme for the metaphysician; with the introduction of love as the force driving us to participation in their divine nature, the philosophy of Plato is transformed into something that has enthralled poets and artists and entered largely into the rapture of the saints; it has become one of the molding influences of civilization. But it cannot be said that this influence has been entirely for good. From this source has come the popular notion of «Platonic love,» which has acted as a befuddling and enervating ferment in society. It is fair to add that Plátonic love, as most of the poets have understood it, is the very reverse of what Plato himself had in mind. Petrarch, for instance, would absorb the universe into his passion for a woman; Plato would forget the woman in his pursuit of ideal beauty. It is right to remember also that the conclusion of the 'Symposium' contains the extraordinary confession of Alcibiades, in which, as if Plato was concerned to remove any misunderstanding of his doctrine, Socrates is pictured as the stalwart soldier and as a lover, proof against every seduction of the flesh, a man of iron character above all. Nevertheless Plato's language, when dealing with the passion of beauty, is sometimes unguarded. The 'Symposium' is commonly regarded as Plato's most perfect literary production, as perhaps the most perfect piece of prose composition of any age or in any tongue.

PAUL ELMER MORE.

SYMPTOMS, *in medicine,* the phenomena from which are inferred the existence and nature of disease. Symptoms have their seat in the functions which are affected by the disease so as to be raised above their usual activity, or depressed below it, or even to become changed in the nature of their action. The organs themselves are often changed in their appearance, structure, size, etc. Symptoms may be perceptible by the patient alone (for example, pain and all change of sensations), or by the physician also (for example, all diseased movements). The more a function or an organic system is extended through the body, the more frequently will it be the seat of morbid phenomena. The nervous, the vascular and the cutaneous systems, for instance, are affected in most diseases; hence also irritability, the power of nutrition, etc., which extend through the whole organization, are so easily affected by diseases, and thus afford symptoms. If the latter are in the organs originally affected they are called idiopathic; but if they are caused by sympathy with other and distant parts, they are called consensual or sympathetic. The temperament, age, sex, mode of living, etc., of the patient produce a considerable variety in the symptoms of every disease. When they are indubitable signs of a particular disease, symptoms are called pathognomonic.

SYNAGOGUE. See JEWS AND JUDAISM.

SYNAPTA, a genus of a group of holothurians distinguished by the non-development of an *ambulacral system.* Locomotion in *Synaptæ* is effected by the muscular contractions of the body, aided by the presence in the skin of anchor-shaped spicules of lime, which these animals use to fix one portion of the body, while the other portion is pulled forward. These animals live in muddy coasts and form mud-cases. See HOLOTHURIA.

SYNCHRONIZER, an instrument in common use in electric-generating stations employed to indicate the relation between the frequency of two or more alternating current generators and especially to show when a generator is operating at the same frequency as others with which it is the desire of the engineer to connect it, in the same circuit. A variety of the instrument is also employed to determine when the voltages of two circuits are in phase with each other. A common form of the instrument is a small motor the armature of which is connected to one generator and the field-windings to another. By an arrangement of armature coils a rotating field is produced which turns the armature in one direction or the other according to the difference in phase between the circuits. A pointer turned by the armature shows which generator is fast and which slow. Another form consists of two incandescent lamps connected in the two circuits in such a manner that they light up or remain dark when circuit is closed. Consult Jansky, C. M., 'Electrical Meters' (New York 1913) and Edgcumbe, K. W. E., 'Industrial Electrical Measuring Instruments' (ib. 1908).

SYNCHRONOGRAPH. See TELEGRAPH

SYNCHRONOUS MOTOR. See ELECTRICAL TERMS.

SYNCLINE. See FOLD.

SYNCLINORIUM. See FOLD.

SYNCOPATION, *in music,* an alteration of the rhythm, by driving the accent to that part of a bar not usually accented.

SYNCOPE. See FAINT.

SYNCRETISTIC CONTROVERSY, the name given in church history to the disputes which attended prolonged and repeated efforts in the 17th century to bring about the union of all Protestant churches. George Calixtus, professor of theology at Helmstadt, was the author of the proposition, which was brought forward at intervals from 1645 to 1686, when the discussion was finally abandoned. See LUTHERANISM.

SYNDIC, (1) in government and commerce, an officer in various countries entrusted with the affairs of a city or other community, company of art or trade, etc., who calls meetings, makes representations, etc. (2) Also a person appointed to act in some particular affair in which he has a common interest with his constituents, as when he is one among several creditors of the same debtor. Mayors of Italian towns bear the title of syndic.

SYNDICALISM, a political and industrial doctrine which demands that the means of production, distribution and government shall be turned over to all those workers who are actively useful and necessary in the community. There are many different views on the subject, held by the opponents and believers in the movement, but a general description is aimed at here. It is antagonistic to every other form of control, whether by government, existing labor unions or by capital. The motivating and regenerating force of syndicalism is to come from the enthusiasm of the workers themselves. It distrusts organization, delegates and all forms of leadership except that of the propagandists. Force is the basis of society, and this weapon is to reform the world. The first objective aim is to eliminate the present owners of production. The means to accomplish this vary in the theories of different exponents of the doctrine, but they may be generally outlined here. Sabotage, boycotting, strikes (qq.v.) and disturbances of all kinds are legitimate. They propose first, by anti-militarist propaganda, to avert the possibility of armed suppression, and then to use their ultimate weapon, "the general strike." This demands the stoppage of every activity and the consequent crippling of the entire government, which, bereft of armed force, will be compelled to capitulate to the working class. This having been accomplished, they then propose to abolish property and masters; level the reward of all work; and carry on trade, production and education by trade unions and local organizations. Syndicalism differs from socialism in that the former demands social revolution through incited labor to abolish capital; whereas the latter expects to work reform through political agitation by gaining majorities in existing governments. Furthermore, Socialism aims at further centralization of government control and depends on rich unions with capable leaders, while Syndicalism prefers poor unions and actual leveling of authority. It differs from the I. W. W. movement in that in its constructive policy it aims at decentralization of trade power, instead of one tremendous all-embracing union of workers, modeled on the lines of capitalistic organization. The movement began in France in 1892, where prior to the European War there were 600,000 avowed Syndicalists. From France it spread to Italy where it was taken over chiefly by the agriculturists who at the same period owned 200,000 acres of tillable lands farmed on the co-operative plan; and the entire railway system was under the influence of Syndicalists.

The movement has a large following in England, some 60,000 being present at a conference held before the war. In America a similar movement began under the direction of the I. W. W. Russia has many different classes of labor agitators,— the Bolsheviki embody many Syndicalist principles. Traces of it are found also in Spain, Greece and Latin America. Consult Brooks, T. G., 'American Syndicalism' (1913); MacDonald, 'Syndicalism' (1913); Lewis, A. D., 'Syndicalism and the General Strike' (Boston 1912); Clay, Sir Arthur, 'Syndicalism and Labor' (London 1911); Challaye, F., 'Syndicalisme revolutionnaire et syndicalisme dans l'evolution sociale' (Paris 1908); Harley, J. H., 'Syndicalism and the Labor Unrest' (in the *Contemporary Review*, March 1912); Kleinlein, Andreas, 'Der Syndikalismus in Deutschland' (Brussels 1912); Lanzillo, A., 'Le movement ouvrier en Italie' (Paris n. d.), and the works of Georges Sorel.

SYNDICATES, a name given in the United States to those combinations of capitalists organized for the purpose of controlling production and raising prices. The term is also used of associations which buy a literary or artistic product outright from the author and market it to subscribers simultaneously in non-contiguous parts of the country. Perhaps the most familiar example of this is the colored Sunday Supplements which appear in different journals on the same day at points throughout the continent from the Atlantic to the Pacific.

SYNDROMES, Endocrinous. The conceptions concerning the push that lies behind the metabolism of the human body even in recent years have been all too elementary and simplistic. They have, however, slowly and gradually undergone modification until the importance of a number of overlooked structures have forced themselves within the past 10 years (1910–20) almost with a rush upon the medical horizon. These structures are the endocrinous glands or the hormonopoietic system. Their study now constitutes an enormous specialty.

As early as 1828 Parry called attention to the relationship between enlarged thyroid and rapid heart beat, since which time the works of Johannes Müller, Addison, Gull, Brown-Séquard, Marie and many others have served as starting points for the building up of a rich structure which is amply recorded in a score of monographs. The chief of these are Biedl, 'Internal Secretions' (bibliography of 4,000 titles, 1913); Falta, 'Ductless Glands' (1915); Parhon et Golstein, 'Les Sécrétions Internes' (1909); Levy and Rothschild, 'Endocrinologie' (1913); Gley, 'Les Sécrétions Internes' (1914); Sajous, 'Internal Secretions'; Pende, 'Endocrinologia,' and the special articles in Lewandowsky's 'Handbuch der Neurologie' (1913). In addition to these a large number of special monographs upon the individual organs have been written all of which may be found in the works here quoted in the *Bibliography*.

Out of this prodigious development, much of which is evanescent and hastily constructed, a large amount of solid substance remains and a number of permanent acquisitions have been made. The net result has been to show much more essentially than ever before the fundamental physicochemical foundations of biological metabolic processes as they are utilized in the upkeep of the animal machine. The viewpoint has been attained that a marked degree of chemical interrelationship takes place between the different organs of the body. That this is automatically regulated through the vegetative nervous system (the old sympathetic) chiefly, apparently in some cases, though this is by no means clear, solely through chemical regulation. The disorders of this adjustment now constitute a special department of vegetative neurology, and are most conveniently grouped under the terms endocrinology, or the endocrinopathies.

In the earlier period of the study of these endocrinopathies individual disease groups, uniglandular syndromes, were isolated. Among the most accentuated of these were Addison's disease, diabetes mellitus, myxedema, cretinism and acromegaly, but of recent years it has been increasingly emphasized that whereas a certain group of symptoms, which may be linked to plus or minus activities of one or another gland may be most prominent, nevertheless other glandular modifications are bound up in them and are not to be neglected. Hence has arisen the viewpoint that most of the endocrinopathies are, strictly speaking, poly- or pluri-glandular syndromes.

For many years, even back to the earliest days of primitive animistic magic, it has been held that every living tissue yields a chemical product which will act upon other tissues. The early alchemistic studies, those of Paracelsus, to the latter work of Hahnemann, and the isotherapists, are all attempts to co-ordinate a host of empirically observed facts. They are all worth rereading if the reader will put himself in sympathy with them through a comprehension of the now strange symbols then used.

Endocrinous glands for the present purposes are those structures which yield products termed hormones and chalones having some definite or specific action related to, yet different from, enzyme activities. These structures are developed from different embryological formations. The hypophysis (posterior lobe) and chromaffin tissues (suparenal chiefly) are nervous; the thyroid and pituitary (anterior lobe) come from the buccal cavity; the pancreas and mucosa of the small intestine from the intestine, the parathyroids and thymus from the branchial arches (old gill slits of fishes), the gonads (testes and ovary) and the interrenal bodies from the genital ridges. Some of these, in humans, merge into one structure, as thyroid and parathyroid, as chromaffin and interrenal cells in the suprarenals, as hypophysis (posterior lobe) and pituitary (anterior lobe).

The present article will attempt to sketch only the general outlines of the various uniglandular and pluriglandular syndromes. The more radical French school is followed, but at the same time attention should be called to the fact that the French school presentations contain gross fallacies, and should be read *cum grano salis*. Still the clinical suggestions of these writers are so rich that it is felt to be a better course to call the attention of the physician to possible relationships rather than to take the more conservative attitude of directing attention only to that which can be indubitably proved. This whole subject is still so largely empirical that the principle of putting the hypotheses to a test will be found to be more advantageous than that of believing only the obvious. The former attitude may result in gaining useful therapeutic truths, the latter becomes monotonous and frequently encourages stupidity.

The more recent suggestive and extreme summaries of Biedl, Falta, Laignel-Lavastine, Levi and Rothschild are therefore here summarized.

Uniglandular Syndromes.— *Thyroid.*— Myxedema.— The chief symptoms are arrest of development, dwarfism, infantilism, infiltration of skin and mucous membranes, mental torpor, slow ideation, defective memory, apathy, laziness, slowness, sleepiness, taciturn, awkwardness. The pulse is usually small, rapid and irregular, at times increased tension. There are constipation, diminished urination, hypothermia and chilliness of the skin. Reflexes diminished. The voice is frequently nasal, slow, monotonous and raucous. Headache is frequent and at times epileptic attacks occur. These are all symptoms of diminished secretion.

Exophthalmic Goitre.— A more or less complete catalogue of findings for a lot of cases will include tachycardia, arrhythmia, anxiety, pulsations in the neck, exophthalmos, epiphora, v. Graef's, Stellwag's, Möbius' symptoms, facial paresis, cramps, tremors, neuralgias, chiefly frontal and ocular, colic, hot flashes, profuse sweats, thermophobia, engorgement of the skin, dermographism, transitory edemas, pigmentation, urticaria, alopecia, diminution of electrical resistance, albuminuria, polyuria or glycosuria, anorexia, bulimia, vomiting, ptyalism, hyperchlorhydria, diarrhea, dyspnea, amenorrhea, atrophy of mammæ, loss of flesh, agitation, emotional instability, volubility, insomnia, anxiety, excessive anger or reverse, maniacal excitement, marked depression, cyclothymic variations, confusion, epileptic attacks. Eppinger and Hess have endeavored to separate a vagotonic and sympathicotonic type.

In the vagotonic type the more prominent signs are decreased lacrymation, less exophthalmos, with enlargement of the palpebral fissures, v. Graef's sign, abundant sweating, diarrhea, mild tachycardia, no alimentary glycosuria, pilocarpine and oculocardiac reflexes positive. In the sympathicotonic types there are exophthalmos, dryness of eyes, violent tachycardia, glycosuria, oculocardiac reflex reversed or absent, increased reaction to adrenalin. Most cases are mixed in type. In all save infectious forms psychical influences are striking and psychotherapy is extremely valuable in the early stages, less so in chronic cases. Money worries bulk large in the etiology of the psychogenic cases.

Thyroid insufficiencies, other than those of myxedema, are infantilism, obesity, Dercum's syndromes, pseudolipomata, alopecia, precocious loss of hair, scleroderma, urticaria, pruritus, recurring herpes, transitory edemas, migraine, asthma, constipation, mucous enterocolitis, acrocyanosis, Raynaud's syndrome, localized erythemas, rhinorrhea, glucose tolerance, genital instability, chilliness, mammary hypertrophy.

Thyroid Instability (Levi and Rothschild).— From dyshypothyroidism: chilliness, baldness, headaches, depression, crying, giddiness, passing edemas, neuralgic pains, suffocations, shivering, hot flushes, at menstrual period. With predominant dyshyperthyroidism: thinness, increase of eyebrow development, hot flashes, palpitation, intestinal spasms, irritability, emotionalism, phobias, inquietudes, migraine, asthma, hyperidrosis dysidrosis, tremors. Mixed cases: chilliness, shivering, migraine, frequent urination, neuralgic pains, distractable reddening of eyebrows, catamenia; neuralgias, anxiety, dilatation of palpebral fissures, swelling of feet, variations in volume of the feet, tremors, nervous crises, hysterical attacks.

Parathyroids.— Tetany.— This syndrome is unquestionably related to parathyroid loss or deficient Parkinson's syndrome(?). The viewpoint of Lundborg and of Gauthier is that this syndrome belongs here, and is a hyperfunction disorder, but it rests on very unstable foundations.

Thymus.— Vagotonic Symptoms of Basedow Syndrome(?): Profuse sweating, palpitation, lymphocytosis, eosinophilia, sensation of weakness.

Myasthenia of Erb-Goldflam(?): Headache, ptosis, external ophthalmoplegia, fixed or transitory palsies principally of the face, the neck, myasthenic electrical reaction.

Thymus Loss: Idiocy of Klose and Vogt.

Tetany(?): Basch.

Suprarenals.—Addison's Syndrome and Suprarenal Insufficiency: Asthenia, arterial hypotension, morning nausea and vomiting, lumbar pains, melanoderma, white lines on the skin, amyotrophy, abulia, depression. At times myoclonus, epileptic attacks, tetany, periodic palsies, delirium, mental confusion, sudden death.

Suprarenal-genital Syndrome: External feminine pseudo-hermaphroditism with virile secondary sexual characters; suprarenal virilism; amenorrhea, gynecomasty, adiposis with easy bruising, all signs of feminine maturity; hypertrophy of the clitoris, hypertrichosis of masculine type, masculine voice, muscular and nervous hyperasthenia, active and violent sexual inversion; arterial hypertension, arteriosclerosis; glycosuria.

Sympathetic Paraganglia.— Chromaffin cells of the solar plexus, aortic paraganglion of Zuckerkandl, cardiac paraganglion of Wiesel and Wiesner, Luschka's carotid and coccygeal glands, tympanic paraganglia. The syndromy of the affections of these glands is entirely obscure.

Pancreas.— Diabetes Mellitus: Glycosuria, polyuria, polyphagia, polydipsia; neuralgias, pruritus, impotency, constipation, dry mouth, dry skin, diminished perspiration, atrophy of the testicles, abolition of the tendon reflexes, arterial hypertension, asthenia, headache, susceptibility to cold, perforating ulcer of the foot, syncopies, comatose or apoplectiform attacks, paralyses, vertigos, asthmatic dyspneas, pseudo-angina, narcolepsy, depression, apathy, hypochondria and coma.

Hypophysis.— Froehlich's Genital Adiposity Syndrome: Adiposity, arrest of development or regression of the genital glands, of the genital organs and the corresponding secondary sexual characters; somnolence.

Syndrome of Hypophyseal Insufficiency of Rénon and Delille: Tachycardia, instability of the pulse, arterial hypotension, insomnia, anorexia, distressing sensation of heat, exaggeration of sweat secretion.

Acromegaly: «A simple hypertrophy, not congenital, of the upper and lower extremities and also cephalic,» headache, amenorrhea, tendon reflexes increased, arrhythmia, syncope, perspiration, polyuria, glycosuria, sensitiveness to cold, neuralgias, acroparesthesia, cramps, lancinating pains, lassitude, irritability, depression.

Gigantism: «Acromegaly of the subjects in the epiphyseal cartilages which have not yet ossified,» impotency, amenorrhea, indolence, infantilism, abulia, asthenia, glycosuria, polyuria.

Diabetes Insipidus(?): Polyuria, polydipsia.

Pineal.— Genital Macrosomia: Abnormal increase in height, premature genital and sexual development with secondary sexual characters, hypertrichosis, exaggerated mental precocity.

Pineal Adiposity: Diffuse obesity.

Choroid Plexus.— Hydrocephalus: Hypertension of the cerebrospinal fluid, rapid development, nervous and mental syndrome of ventricular hypertension, obnubilation, idiocy.

Ovaries.— Infantilism: Amenorrhea, absence of secondary feminine characters, obesity, deficiency of hair, childishness.

Acquired ovarian insufficiency: (*a*) Peripheral vasodilatation, subjective crises of heat, sweating, continuous or paroxysmal tachycardia, palpitations, arterial hypertension, insomnia, severe headache, facial neuralgia, lumbago, neuromuscular asthenia, memory instability, irritability, enervation, hysterical crises; exaggeration of the sexual instinct(?), more often absent or inverted; obesity, restlessness, anxiety, phobias, impulsions, gastrospasm, constipation, vomiting, vertigo, syncope.

(*b*) «Vagotonic crises» before the menses and at the beginning of pregnancy, pallor, tendency to syncope, nausea, vomiting, constipation, diminished arterial tension, pulse rather slow, oculocardiac reflex positive, Samogyus' sign, psychic depression particularly connected with the development of the corpus luteum. These crises occurring before menstruation or at the beginning of pregnancy must not be confused with the reactionary dyshyperthyroidism of the menopause marked by flashes of heat, sweating, hypertension, paroxysmal tachycardia, palpitations, anxiety.

«Hyperovaria» (Dalché): Precocious puberty, copious menstruation, pain before and during the first days of the period, intermenstrual leucorrhea, developed sexual instinct, well-marked eyebrows, thinness, pallor, small breasts, large pelvis, rounded lower limbs contrasted in size with the upper ones, arterial hypotension, craving for movement and action, enervation, tendency to loquacity, erotic crises.

Testicles.— Infantilism: Defective development of the male genital organs, absence of secondary sexual characters, obesity, deficiency of hair, length of the lower limbs, small cranium, childishness.

Acquired Testicular Insufficiency: Increase in height, diminution of the pilous system, glabrous state of the body, tendency to obesity, gynecomasty, frigidity, impotency, senility, arterial hypertension(?), asthenia.

The types of testicular insufficiency according to Rebattus and Gravier are: (*a*) The sterile. (*b*) Eunuchoid gigantism, because the internal secretion of the testicle is established late. In this case there is a prolonged infantilism. (*c*) Eunuchism by castration characterized by gigantism and infantile appearance. The secondary sexual characters do not appear. (*d*) The reversive infantilism of Gandy, where simply a sort of asexual condition is noticed, with attenuation of secondary sexual characters and a certain degree of obesity, with late testicular difficulty in the adult.

Dyshyperdiastematia: Lower limbs short and cranium very large, pilous system well developed, especially the mustache, thinness, persistence of youth, a degree of arterial hypertension, virile character, activity, moral and physical energy.

Prostate.— Prostatic Insufficiency: Asthenia, diminution of potency, neurasthenia, at times suicide.

Hypertrophy of Prostate: Arterial hypertension, retardation of the heart, cerebral hemorrhages, genital excitation.

Pluriglandular Syndromes.— Basedow's disease with thymic hypertrophy and vagotonic symptoms; sclerodermia and tetany, amenorrhea; Addison's syndrome; acromegaly, etc.

Myxedematous with Thymic Hypertrophy. Tetany, acromegaly, Addison's syndrome, amenorrhea, infantilism, mammary hypertrophy, etc.

Acromegalic or ovarian insufficiencies with various disturbances, psychic, nervous, vasomotor, trophic, etc., connected at one time with the myxedematous, at another with the Basedowian series.

Ovarian Predominance.— Thyroid Reaction to Ovarian Insufficiency: Tachycardia, palpitations, perspirations, nervous irritability, vertigo, scanty urination, trembling, anxiety, etc.

The differences between these nervous manifestations and the picture of the attenuated forms of exophthalmic goitre are very slight, says Laignel-Lavastine. This pathogenic conception permits of important therapeutic results; one may ask, for example, whether the anti-Basedowian therapy with hematothyroidin would not be of advantage in the nervous and psychic disturbances of the normal menopause which repeat one feature after another of the Basedowian series.

Dyshyperovaria of the Hypothyroid: Anticipation, prolongation and copiousness of the menses, menorrhagia, metrorrhagia.

Thyro-ovarian Disturbances of the Same Significance.— Either ovarian insufficiency in the myxedematous series, or the dyshyperovarian in the Basedowian series; in either case the nervous disturbances of the dysthyroid are modified by all the factors of the ovarian rhythm, whatever they may be.

Hypophyseal Predominance.— Infantile giants, with their clinical varieties: feminism, eunuchism, cryptorchidism, feminine pseudohermaphroditism, mental infantilism.

Acromegalics with deficiency syndromes, myxedema, infantilism, amenorrhea, obesity, asthenia.

Acromegalics with syndromes of hyperactivity, more or less vicious, synergetic or substitutive; simple or exophthalmic goitre, arterial hypertension and atheroma, lacteal secretion.

Suprarenal Predominance.—Addisonian with amenorrhea, impotence, chilliness, tetany or, on the other hand, exophthalmic goitre.

Very often Basedowians, acromegalics, giants, with spontaneous glycosuria, alimentary or merely adrenal, the latter making it possible in certain cases to suppose a certain degree of suprarenal hyperactivity.

Without Marked Predominance.— The case of Claude and Gougerot is an example: Loss of sexual characters, countenance old-looking, skin thickened, wrinkled, pigmented; chilliness, absence of perspiration, asthenia, arterial hypotension, tetany; testicular, prostatic, suprarenal, thyroidal and perhaps parathyroidal atrophy. Consult Jelliffe and White, 'Diseases of the Nervous System' (3d ed., 1919; chap. III, 'The Endocrinopathies').

SMITH ELY JELLIFFE, M.D.

SYNERGISM, the co-operation of man with God in the act of his conversion; the term was first employed to designate the relation of man to the Holy Spirit in the work of conversion, as defined by Melanchthon in the 'Interim' (1548). Luther, in his commentary on Genesis, allows to man no part whatever in this act: «In things spiritual and divine which relate to the salvation of the soul, man is like the pillar of salt into which Lot's wife was transformed; nay he is like to a block and a stone, a lifeless statue which has no use of eyes, mouth, of any of the senses, or of the heart.» Melanchthon's doctrine (which, however, he soon retracted) was that «God does not deal with man as with a block, but draws him so that his will co-operates»; it was this term of co-operation that gave to Melanchthon's doctrine the title Synergism.

SYNESIUS, sĭ-nē'shĭ-ŭs, Neoplatonist philosopher: b. Cyrene, 370 A.D.; d. about 415. He studied in Alexandria, where he was the friend and pupil of Hypatia (q.v.). In 409 he was baptized in the Christian Church and the following year consecrated bishop of Ptolemais, in North Africa. His philosophical views are expounded in his writings,— homilies, letters, hymns and other literary works. In these he exhibits multifarious learning, keenness of intellect and a glowing style. The Christian dogmas which seem to conflict with his philosophical views he explains allegorically. Consult Migne, 'Patrologia Græca' (Vol. 66, 1859); Volkmann, 'Synesius von Kyrene' (1869); Crawford, W. S., 'Synesius the Hellene' (London 1901); Gardner, A., 'Synesius of Cyrene' (ib. 1886).

SYNGE, sing, **John Millington,** Irish dramatist: b. Newtown Little, near Rathfarnham, 1871; d. 24 March 1909. He received his education at Trinity College, Dublin, where he was graduated in 1892. For about seven years he studied music in Germany and languages in Germany, Italy and France. He spent several years in the Latin Quarter of Paris where he gave his attention to the study of decadent French literature, especially to Baudelaire. He accomplished little in Paris but being meanwhile interested in Ireland, in 1899 William Butler Yeats persuaded him to abandon his efforts as a French literary critic and study the social types, manners and customs of the inhabitants of the Aran Islands, a people who still retained their primitive Celtic culture. He finally settled in Dublin where he became one of the literary advisers to the Abbey Theatre and where he produced his dramas. These are remarkable for the angry protests and discussions which they provoked when produced in Ireland and in the United States. His first play was 'In the Shadow of the Glen' (1903); followed by 'Riders to the Sea.' 'The Tinker's Wedding,' although written in 1902, was not produced until 1909. 'The Will of the Saints,' a tragic-comedy (1905), was performed in German at Berlin in 1906. In 1907 appeared 'The Playboy of the Western World,' about which there arose violent discussion and protest. Some critics hail it as the best comedy in English since Sheridan, while in Ireland it is regarded as a savagely ironical treatment of a situation more frequently found in Baudelaire than in contemporary peasant life in Ireland. These plays have a wonderful diction and set the fashion for that peasant drama which became the most prominent feature of the Abbey Theatre. In design and substance, however, Synge's dramas are of the Gallic decadence. 'Riders to the Sea,' perhaps the least objectionable, is, *mutato nomine,* Pierre Loti's 'Pêcheurs d'Islande,' in an Irish setting. The dominant idea of 'The Well of the Saints' (1905) is from a play of Clémenceau's. The story of 'The Shadow of the Glen' is found in Voltaire's 'Zadig,' and the notorious 'Playboy of the Western World' is merely a dramatization of a work of Baudelaire. The form and tone of the plays of Synge are no less foreign than the substance; there are frequent sneers at the morals and religious practices of the Irish, and in 'The Playboy' are several blasphemous utterances; the characters of the latter are devoid of all semblance of good, and their sole moral motive is «fear of Father Reilly.» In short, Synge is «much Maeterlincked, Baudelaired and Ibsenized, but Gaelicized not at all.» As regards their dramatic and literary value, however, it is admitted that these plays possess a certain beauty. The talk of the Irish peasant is at times shot through with a queer poetic imaginativeness. It abounds in quaint terms, idioms and images unknown to English. These peculiarities Synge has reproduced and accentuated. And it is little wonder that to audiences strangers to the Gaedhaltacht his work should appeal with a sense of delighttul freshness and originality. Synge's peasants are viewed through a distorted medium. He himself had admitted in private life that the Connacht peasant whom he put upon the stage was not the peasant as he existed in real life, but the writer's own literary fancies set amid Connacht surroundings. Consult article by D. J. O'Donoghue (in *Irish Daily Independent,* 21 Aug. 1911) in which he points out the foreign sources of Synge's plots; O'Neill, George (in *Irish Catholic,* 23 Dec. 1911); *America* (New York, issues September-October 1911); Yeats, J. B., 'J. M. Synge and the Ireland of His Time' (New York 1912). See Irish Literary Revival; Playboy of the Western World; Riders to the Sea.

SYNGENETIC, a term applied to ore deposits that have been formed at the same time as the enclosing rocks, as for example the interbedded iron ores of the Birmingham region in Alabama, which were formed as sediments during the Clinton (q.v.) epoch. Epigenetic deposits, on the other hand, were introduced after the enclosing rocks were formed. Any vein of ore would then obviously be epigenetic. See Ore Deposits; Economic Geology.

SYNGNATHIDÆ. See Pipe-fishes.

SYNNÖVE SOLBAKKEN, sĭn'nė-vę' sôl-bäk'kĕn, a peasant-romance by Björnstjerne Björnson, was published in 1857. Without any knowledge of Auerbach's 'Schwarzwälder Dorfgeschichten' or George Sand's country tales, Björnson introduced this very type of the short story in Norwegian literature. His thorough knowledge of the peasant class and his study of the old sagas furnished the material on which his peasant stories are based. 'Synnöve Solbakken' met with instant acclaim and has been translated into most European languages. Thorbjörn, the hero of the story, is a peasant's son, and Synnöve, the heroine, is a peasant's daughter. Thorbjörn has a fiery temper, in fact, he is something of a savage and must, therefore, pass through a hard ordeal before he can become a fit husband for the gentle and lovable Synnöve. This bitter experience tests the devotion of the young people for one another and contributes to bring everything to a happy conclusion. Björnson idealized the peasants of his country. This is due partly to his fondness for the old sagas, partly to his own poetic temperament. His peasant types are decidedly above the average in poetic endowment. They are often able to express their feelings in beautiful poetry, as Synnöve did when she received Thorbjörn's letter written on his sick-bed. Björnson's peasants are noted for terse speech and this trait, too, is in imitation of the saga style, for Björnson wanted to show that the peasants of to-day had more faithfully than any other class in modern society preserved the traditions of a historic past. Consult Jaeger, Henrik, 'Illustreret norsk Literatur historie' (II, 589–639 and 711–768); Brandes, Georg, 'Det Moderne Gjennebruds Maend' (pp. 1–69, trans. by Mary Morison in a volume entitled 'Henrik Ibsen. Björnstjerne Björnson. Critical Studies, by Georg Brandes,' 1899).

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SYNOD, an ecclesiastical deliberative and legislative assembly. The word is synonymous with council, but œcumenical assemblies are commonly called councils and minor ecclesiastical assemblies synods, though these are also styled councils. A diocesan synod is composed of a bishop and the clergy of a diocese; a provincial synod, of an archbishop (or metropolitan) and the bishops suffragan to him; a national synod of all the metropolitans and bishops of a nation. In the Presbyterian Church synods are courts of review immediately superior to the presbyteries and consist of all the ministers and elders who are members of a number of contiguous presbyteries; the supreme council of the Presbyterian Church is the General Assembly.

SYNODICAL PERIOD, is the period between two successive conjunctions or oppositions of a planet with the sun, as observed from the earth. A synodical month is a lunation, being the period from full moon to next full moon or from new moon to next new moon. A synodical month is 29 days, 12 hours, 44 minutes, 2.37 seconds.

SYNONYMS, words of the same language which are the precise equivalents of each other; in popular acceptation, words sufficiently alike in general signification to be liable to be confounded, but yet so different as to require to be distinguished are synonyms. The following pairs of words are pairs of synonyms: teacher, instructor; resemblance, similarity; supposition, hypothesis; beginning, commencement. But words commonly regarded as synonymous are seldom perfectly so, as is seen in works on synonyms. There is always going on in a language a process of «desynonymization» which tends to restrict one member of a synonymous pair to one meaning, the other to another. For example, «wave» and «billow» originally meant precisely the same thing; but «billow» is now restricted to poetical use, while wave is used chiefly in practical matters. The study of synonyms is a valuable intellectual discipline in itself, apart from consideration of its high importance as a guide to the right use of words. «The habit of thorough investigation into the meaning of words, and of exact discrimination in the use of them, is indispensable to precision and accuracy of thought, and it is surprising how soon the process becomes spontaneous, so that one often finds himself making nice and yet sound distinctions between particular words which he has never made the subject of critical analysis.» Consult Crabbe, George, 'English Synonyms' (new ed., New York 1891); Fernald, 'English Synonyms and Antonyms' (ib. 1896); Ordway, E. B., 'Synonyms and Antonyms' (ib. 1913); Roget, P. M., 'Thesaurus of English Words' (new ed., ib. 1914); Smith, C. J., 'Synonyms Discriminated' (3d ed., 1908).

SYNOPTIC GOSPELS, those called of Matthew, Mark and Luke, which regard events generally from the same point of view and present strong resemblance to each other. Four hypotheses have been offered to account for the correspondences of the synoptics: (1) Derivation from some common written original. (2) Priority of one of the three and recurrence to that by the authors of the other two. (3) Derivation of all three from the same source in oral tradition. (4) Derivation of all three from the oral tradition, but consultation of Matthew's gospel by Mark; of Matthew and Mark by Luke. See BIBLE.

SYNOVIAL MEMBRANE, the membrane lining the various joints or articulations and which secretes a peculiar fluid — the synovial fluid — for the due lubrication of the joint. See JOINT; MEMBRANE; ARTHRITIS.

SYNOVITIS. See ARTHRITIS; JOINTS.

SYNTAX, *in grammar*, proper arrangement of words under established rules and according to the best usage in order to express ideas. A word expresses a single notion, but by itself is little more than an articulate sound intimating, like the cry of animals, a wish or a feeling. A succession of such sounds, properly arranged and connected for the expression of ideas, becomes language. The art of constructing sentences is, therefore, not less important than the power of speech; it is indeed the intellectual part of language and a characteristic of reason. The first step in syntax is the analysis of sentences; a clear perception of the mutual relations of the several members of a sentence makes the usual rules of syntax appear self-evident truths and in most cases superfluous. See GRAMMAR; PHILOLOGY.

SYNTHESIS (Lat. *synthesis*, from Gk. σύνθεσις, combination, composition), the combination of individual objects or elements of thought into a whole. Thus, by synthesis, separate propositions are combined into a system, or simple concepts into compound and complex ones. In this manner one recognizes that various properties, taken together, constitute the characteristics of some one object. The process, however, does not destroy the identity of the component parts, but merely correlates them into a unity. It is, therefore, the opposite, or complement, of analysis (q.v.), which is the process of distinguishing within some given object the various characteristics of that object, without, however, destroying its unity. Hence, the name synthesis is applied in mathematics and philosophy to a process of reasoning working to a conclusion from propositions that have already been demonstrated, or principles that have previously been assumed or established.

SYNTHESIS, Chemical. The building up or formation of chemical compounds from their elements or groups of their elements. The opposite of analysis, one meaning of which is the breaking up or decomposition of a chemical compound into its elements. Thus the formation of water from its elements hydrogen and oxygen is synthesis, while the decomposition of water into hydrogen and oxygen is analysis. Many of the most important manufacturing processes are synthetical. The synthesis of compounds from their individual elements is of great scientific but of little technical interest. However, the recent synthetical process of uniting moist nitrogen and oxygen to form nitric acid by use of the electrical discharge bids fair to be of great interest to mankind because of the use of nitrates as fertilizers. The synthesis of compounds from groups of their elements is of very great industrial importance. Sometimes only a single and simple chemical reaction is required, as, for example, the action of water on quicklime to form slaked lime, while others, such as the manufacture of indigo from naphthalene, require many and complicated changes. There is a great difference as to the ease with which elements or groups of elements unite to form compounds. Some unite readily under ordinary atmospheric conditions of temperature and pressure, while others may require the action of heat, light, electricity, presence of water, etc. Phosphorus and iodine unite the moment they come in contact. Phosphorus and oxygen unite slowly at ordinary temperatures but with violence if the temperature is raised; sulphur and iron do not act at all at room temperature but do so when heated highly; hydrogen and chlorine do not act in the dark at ordinary temperatures but do so with explosive violence if exposed to the light; ammonia and hydrochloric acid or the mixture of bicarbonate of soda and cream of tartar used in baking powder do not react when dry but do so in the presence of water.

Up to 1828 it was thought that all organic chemical compounds, those formed in or produced by animals and plants, could not be prepared in the laboratory by synthetical processes. The action of a «vital principle» or «vital force» was thought to be necessary. Wöhler showed this to be not true when (1828) he prepared urea, an organic substance produced by animals, from ammonium cyanate. Since that time an immense number of other organic substances have been prepared by synthetic processes. Some of the well-known ones are oil of wintergreen, indigo, caffeine, alizarine, etc. The processes used in synthesis have been so thoroughly studied that the chemist has only to find out the exact chemical structure of a compound to be able to prepare it in the laboratory. Sometimes these laboratory processes are too costly to be of technical importance, but often they are of great commercial value. See INDIGO; ALIZARIN.

Many substances are prepared by synthesis that never existed in any plant or animal. They are purely laboratory products. To this class belong most dyestuffs, many valuable medicines and a large number of perfumes and flavoring substances. Consult Berthelot, P. E. M., 'La synthèse chimique' (Paris 1876); Posner, Theodor, 'Lehrbuch der synthetischen Methoden' (Leipzig 1903); Lassar-Cohn, 'Arbeitsmethoden für organisch-chemische Laboratorien' (2 vols., Hamburg 1907).

SYPHILIS. This is a general infectious disease, chronic in character, which may be communicated through inoculative contact or transmitted by inheritance. In the acquired form, it first produces at the point of inoculation a specific lesion termed the chancre, followed by a gradual infection through the communicating lymphatic vessels and eruptions upon the skin and mucous membranes. Later, there may develop in the connective tissue, or in any part of the body, adventitious new growths which may undergo suppurative or destructive changes.

The history of syphilis is shrouded in obscurity; certain writers have sought to trace its origin back to a remote antiquity. It is claimed that syphilis was well known to the ancients, and that descriptions of morbid conditions applying to this disease are found in the Bible, in Egyptian papyri, Assyrian and Babylonian inscriptions, as well as in the ancient Chinese and Japanese literature and the books of the Vedas. The evidence which connects syphilis with these ancient historic records is vague, indefinite and inconclusive. Our actual knowledge of syphilis dates from the appearance of the disease in Europe about the year 1494, and there is much evidence to show that the disease was native in South America and was brought to Europe by Columbus' sailors. There can be no question that gonorrhœa and ulcerative affections of the genital organs resulting from sexual debauch and uncleanliness were well known and frequently spoken of by ancient writers. With the irruption of syphilis in Europe toward the close of the 15th century, and its widespread extension, the identity of gonorrhœa was swallowed up in the greater importance of this newer and more formidable disease. During a long period all diseases of the genital organs were regarded as identical in origin and nature. This doctrine reigned practically supreme for more than three centuries and was not definitely overthrown until 1838. At the present time we recognize that under the general term «venereal» are comprehended three distinct diseases, independent in origin and nature, namely, gonorrhœa, chancroid and syphilis.

Cause.— Since 1905 the cause or etiology of syphilis has assumed an entirely new phase. Previous to that time it was very strongly suspected, especially by those who had followed the development of the science of bacteriology, that the cause must be associated with some variety of specific micro-organism, as was the case with so many other infectious diseases. The history and clinical phenomena of the disease all pointed in that direction. Everything seemed to favor such a theory and there was apparently nothing from the bacteriological point of view which could be urged against it. In 1905, after careful investigation of the primary and secondary lesions in 70 successive cases of syphilis, Schaudinn announced that he had succeeded in finding in each of them a spirillum or spirochæte which he named spirochæta pallida. (This organism is also known as Treponema pallidum). This should be classified as a protozoon. When regarded as a protozoon it is described as one of the flagellated mastigophora which is characterized morphologically by a long slender body with numerous corkscrew-like coils and a flagellum at each extremity. Upon the protozoon supposition it is the pathogenic parasite of syphilis.

The findings of Schaudinn were confirmed by Hoffman and others, and additional investigations were made by Metchnikoff at the Pasteur Institute. Some of the higher apes were successfully inoculated with the organism, the results being especially satisfactory with the chimpanzee. Various methods of staining have been used with this organism. In the Levaditi method the spirochetæ appear as dark spirals upon a pale yellow background, and when a weak counterstain is used they can frequently be detected in great numbers in the liver cells. They have also been found in the tissues of the lungs, spleen and heart.

General Course and Character of the Disease.— Syphilis bears a certain resemblance to the infectious fevers, as smallpox, measles, etc., in its incubation, mode of development and the appearance of a characteristic eruption. In the majority of cases the phenomena of syphilis develop with a certain order or regularity which admits of its division into periods or stages, known as the primary, secondary and tertiary stages. After the introduction of the virus there is no appreciable evidence of its action during a period more or less prolonged, from two to five weeks, on the average 28 days. This period is termed the period of primary incubation or the incubation of the chancre. At the expiration of this period there appears at the point of entrance of the virus the chancre, which is termed the initial or primary lesion of syphilis. This primary lesion constitutes for a time the sole sign, the unique expression of the disease. After the appearance of the chancre there ensues a period of six to seven weeks, termed the period of secondary incubation. During this period, the lymphatic glands nearest the chancre undergo an indolent enlargement, constituting what is termed the bubo of syphilis. After the second incubation the disease is said to become constitutional, although it is not definitely known at what precise time generalization of the virus takes place. Not infrequently there is, during this period, some evidence of constitutional disturbance — headache, neuralgia and febrile disturbance, more or less pronounced — which ushers in what are recognized as the constitutional signs of syphilis, in the shape of eruptions upon the cutaneous surface or the mucous membranes.

The *secondary* stage of syphilis is usually from 18 months to two and a half years in duration. The secondary eruptions are not continuously present, but come out in successive crops. The completion of this stage may mark the definite end of the disease, or there may succeed the tertiary stage, characterized by the appearance of gummatous formations which may affect the sub-cutaneous tissues, the periosteum, the bones and the internal organs of the body. The duration of this stage is practically indefinite. The tertiary lesions may continue to recur for 5, 10 to 15 years, or even during the lifetime of the individual. This division of syphilis into stages is somewhat artificial. It does not always pursue this regular and methodic course with an orderly procession of secondary and tertiary lesions; there is not always a sharp limitation between the stages. Secondary manifestations may continue to recur for several years.

Syphilis, as we comprehend it to-day, has a much graver significance in its relation to the health of the individual than was formerly supposed. Our conception of the range of its pathological action has been gradually enlarged with increasing knowledge of the vast complexity and far-reaching character of its morbid processes. While it was formerly known that syphilis was a constitutional disease and capable of causing changes in the internal organs, these systemic complications were regarded as few in number and of only occasional occurrence. The secondary manifestations visible upon the surface of the body were thought to constitute practically the entire expression of the disease. At the present day, these secondary manifestations are regarded as of subsidiary importance, since they rarely compromise the integrity of any important organ. The tertiary manifestations of the disease — cerebral, spinal, vascular, ocular, pulmonary, intestinal, hepatic and renal affections — constitute the chief significance, as well as the individual danger of the disease. The tertiary lesions of the brain and cord occupy the first rank in frequency as well as in gravity. Of all the menaces to the life and health of the individual from syphilis, lesions of the nerve centres are the most to be feared. The pathological field of syphilis has been greatly enlarged by the inclusion of a group of affections badly termed parasyphilitic, which, though of syphilitic origin and nature, are extremely refractory to specific treatment and practically incurable. As types of this group may be mentioned locomotor ataxia and general paralysis. It has been stated that every hemiplegia occurring in a man less than 40 years of age addicted to alcohol or affected with lesions of the circulatory system is, in nine cases out of 10, of syphilitic character. Practically all cases of paresis and tabes dorsalis are due to syphilis, and the spirochete has been found in the brain spinal cord in these diseases.

Syphilitic Heredity.— From a strictly socio-biological standpoint, the hereditary consequences of syphilis are of the greatest significance. Its pernicious effects upon the offspring give to syphilis an especial importance as a factor in the degeneration and depopulation of the race. Syphilis is recognized as the perfected type of a hereditary disease. No other disease is so susceptible of hereditary transmission, so pronounced in its influence and so destructive to the offspring. The hereditary influence of most other diseases is manifest in the transmission to the offspring of a constitutional protoplasmic state, characterized by a feeble organization and diminished resistance to disease. In tuberculosis and leprosy, for example, the influence of heredity is limited to the creation of a predisposition to disease, from an enfeebled capacity of resistance of the organism, which renders it readily susceptible to the action of the germs of disease. In syphilis there is a direct transmission of the specific qualities contained in the sperm or germinal cells, with the result that the normal processes of nutrition are vitiated and the produce of conception is blighted in its development or destroyed. No disease has such a murderous influence upon the offspring as syphilis.

Syphilis may be transmitted by indirect inheritance through the specifically infected sperm or ovule at the time of impregnation or through the utero-placental circulation in the course of pregnancy. Post-conception syphilis is applied to cases where the mother — or even both parents — may be healthy at the date of conception; the wife is infected during the course of pregnancy and she in turn transmits the disease to the child in utero through the vascular channels of the utero-placental circulation.

Syphilis may be transmitted directly from the father, the mother remaining healthy, although in most cases the mother is infected by the fœtus in utero. It may be transmitted directly by the mother, the father being healthy. The paternal hereditary influence is comparatively restricted; the influence of maternal heredity is much more certain and pronounced. When both parents are syphilitic, the infection of the child is almost inevitable — especially, when the disease of the parents is recent and active. The percentage of deaths from mixed heredity varies from 60 per cent to 86 per cent. The quality of hereditary transmissibility is not impressed upon the syphilitic organism permanently. As the disease grows older there is a progressive enfeeblement of the transmissive power, until it finally becomes extinct. The influence of heredity is rarely manifest after the fourth year; still, there are many well-authenticated cases in which it may be prolonged five or six years or even longer. The attenuating influence of time upon syphilitic heredity is shown in a series of successive pregnancies. The first pregnancies terminate in abortions, which occur at a later and later period; then, still-born children, or children living at birth but which soon die; then, syphilitic children, surviving but showing evidences of specific taint; and, finally, healthy children, free from all signs of the paternal disease. Specific treatment also exercises a powerful corrective influence upon heredity. It frequently happens that if syphilitic parents undergo active treatment before the time of pro-creation the child is born healthy. If this treatment is now suspended, the next pregnancy may result in a syphilitic child. Treatment seems, then, not to entirely extinguish, but rather to hold in abeyance, the transmission capacity.

Hereditary Syphilis.— Death of the child in utero is the most habitual expression of hereditary syphilis. More than one-third of all syphilitic children born alive die within the first six months of their existence. An analysis of statistics from authenticated sources shows that only one child finally survives out of four syphilitic pregnancies. In the immense majority of cases infants with syphilitic taint begin to show signs of the disease from the second week to the second or third month. It was formerly thought that if there were no evidences of contamination within the first year it might be assumed that the child had escaped. It is now known that even if the syphilitic child has escaped the early manifestations of the disease it may be doomed to the lesions of late hereditary syphilis, which are especially liable to appear at the period of second dentition, the period of puberty, from the 20th to the 30th year, or even later.

When a child the subject of inherited syphilis is born alive it may be apparently healthy and present no positive evidences of specific taint. Very often lesions of the osseous system are the only evidences of inherited disease manifest at birth. After a certain period, usually within a few weeks or months, the child may begin to show the stigmata of the parental disease. The surface manifestations of inherited syphilis, like those of the secondary stage of the acquired form, are at first generalized and diffuse. Later, they become more discrete, with a tendency to localize themselves in certain regions. Lesions of the internal organs often coexist with the earliest cutaneous manifestations. Hereditary syphilis is further differentiated from the acquired form by certain lesions which are its exclusive products. They are not in their essential nature syphilitic, but rather the result of changes impressed upon the fœtus in its formative or developmental stage. They present the characters of dystrophies or degenerations due to perversions of nutrition. These dystrophies may affect the entire body or be limited to a single organ or a system of organs.

The influence of hereditary syphilis is often manifest in a native debility or inherent incapacity for life. Many syphilitic children are endowed with a feeble vitality, so that they succumb to slight causes of disease. They die at an early age, often with no obvious signs of disease but simply from an inability to support life. They are the subjects of what may be termed «sudden, inexplicable death.»

In another class of cases there is an arrest or retardation of development; the children are stunted or dwarfed; they develop slowly physically and mentally; they are often feeble-minded or idiotic. The term «infantilism» has been employed to express the sum total of these characteristics. In other cases there are presented anomalies or marked deviations from the normal development, seen in the bones of the cranium and in the long bones, producing malformations of varied types, such as incurvation of the tibia, pigeon-breast, deformity of the thorax, curved spine, deformed pelvis, etc. These dystrophies may be expressed in such marked deviation from the normal type that the result is a monstrosity.

Heredo-Syphilis.—The effects of hereditary syphilis are not limited to the immediate descendants, but they in turn are capable of transmitting these dystrophies and organic defects to the third generation. Observation shows in the most positive manner that the influence of heredo-syphilis in determining abortions, still-born children and various organic defects is scarcely less marked than that of syphilis directly acquired. It would seem that while the contagious activity of the disease is entirely extinct, the nutritive disturbances set up in an organ or system of organs of the progenitors may be handed down to their offspring.

Syphilis as a Social Danger.— It is now generally recognized that syphilis, with alcoholism and tuberculosis, are the three great plagues that afflict modern humanity. Owing to its wide prevalence and the dangers to the personal health and life of the individuals affected, syphilis constitutes a serious menace to the public health. The amount of morbidity from this cause in any country or community is an unknown and unknowable quantity, since owing to its secret and shameful character cases of this disease are not subject to official registration. The spread of syphilis is favored not only by the fact that its contagious activity and transmissive power persist during a prolonged period but because it is exceedingly prolific in its sources and modes of contagion. While it is commonly propagated through sexual relations, syphilis is not necessarily so contracted. It may be conveyed by accidental inoculations, in the ordinary relations of life, in various industrial and professional occupations. Kissing is a very common mode of infection and a very large number of cases of contagion occur in this way. A syphilitic infant may infect a healthy nurse, or a healthy infant may receive infection from a syphilitic nurse in the act of suckling. Syphilis may be transmitted through the intermediary of any object upon which the secretions of the syphilitic have been accidentally deposited. It may be conveyed by drinking vessels, spoons, knives and forks, household effects, pipes, toilet articles and other objects too numerous to mention. Certain occupations favor the spread of syphilis, especially that of glass blowing, where the infected blow-pipe is passed from mouth to mouth. Syphilis is not infrequently communicated in barber shops, through razor wounds or through the use of shaving brushes, soap or towels. Infections in professional life are not uncommon. Physicians and accoucheurs have acquired syphilis in the examination and treatment of syphilitic patients. Every syphilitic individual is the source of possible danger to persons with whom he comes in intimate contact. A case of syphilis in a family may be the origin of many innocent infections. The syphilitic child may infect the nurse and members of the family; these in turn may affect others. Veritable endemics of syphilis, amounting to 10, 15, 20 or more infections, have originated in this way. It is this quality of expansiveness, this capacity of morbid irridiation through family and social life, that gives to syphilis its superior significance as a social danger.

It is especially, however, in its relation with marriage that the ravages of syphilis as a social plague are of the highest interest and importance. By its inhibitory influence upon the productive energy of the family, syphilis may seriously compromise or entirely defeat the social aim of marriage — the raising of children. When it does not destroy the product of conception, it may blight its normal development. The subjects of inherited syphilis that survive are stamped with inferiority and compelled to pass through life bearing the stigmata of degeneration or disease. A syphilitic man should not marry so long as he is capable of carrying contagion to his wife or begetting syphilitic children. Since the contagious and transmissive power of the disease is gradually exhausted, syphilis constitutes only a temporary barrier to marriage, which may be removed by time and treatment. It may be formulated as a general rule that a syphilitic man should not marry until after a certain period (on an average four years) has elapsed since the date of his infection, during which time he should receive sufficient specific treatment. A still longer period of probation would afford an additional guarantee of safety. It is to be observed, however, that there may be contra-indications to marriage which arise from risks to the personal health of the individual by reason of his disease. The syphilitic man may be exposed to dangers, the consequences from his disease, which unfit him for the responsible position of head and support of a family. The possible existence of such disqualifying conditions must always be taken into consideration when the question of marriage is concerned.

Diagnosis.— The chancre or indurated ulcer which appears upon that portion of the body where inoculation has taken place, which may be at any point where the skin or mucous membrane has been broken or injured, has been regarded since the time of John Hunter as the distinguishing evidence that syphilis is present. The discharge or secretion from such a sore, as well as the blood of the individual who has the sore, both of which contain the germs of the disease are the media by which the disease is communicated, while the period during which such communication is possible may continue through several years if the disease remains untreated. These germs produce a specific antigen, by their action upon the blood and tissues, and this forms the basis for the Wassermann test in the diagnosis of syphilis. This test works upon the theory of deviation of the complement by antigen substances contained in the syphilitic fluid blood or cerebro-spinal fluid and prevents or fails to prevent the lytic action of the hæmolysing fluid, according as syphilis is present or absent.

The Wassermann test is made in the following manner. Certain definite quantities of tissue, representing the antigen, are taken from the liver and spleen of a syphilitic fœtus, together with a definite volume of the blood serum of the individual upon whom the test is to be made. They are mixed in a test tube and fresh normal guinea-pig serum which contains the complement is added to them. The tube is then placed in an incubator, at the temperature of the body, for one hour, after which its contents are poured into a second test tube which contains a mixture of red blood cells of a sheep, or other suitable animal, suspended in a physiological salt solution plus the serum of a rabbit which has been immunized to the before-mentioned red blood cells of the sheep. If the individual whose serum was placed in the first test tube actually has syphilis there will be no hæmolysis of the red blood cells in the second tube after it has been kept in the incubator for the required period of one hour. In other words there is fixation of the complement and the reaction is said to be positive. If, on the other hand, hæmolysis of the red blood cells takes place the reaction is negative and the individual presumably does not have syphilis, or has it in a quiescent condition. Various errors may occur with the Wassermann test, so that it is not regarded as absolutely reliable. This has resulted in the development of various modifications of the test, the one which has been regarded as most satisfactory being known as the Noguchi nodification. The Wassermann test or the Noguchi modification must be repeated at intervals of a month or two for a year or more, even though it should be negative on each occasion, to determine whether the disease has been entirely eradicated.

Treatment.— Mercury and the iodide of potassium have until a very recent date formed the basis of most of the successful treatment of syphilis. A great deal of enthusiasm was excited by the first published results of the use of salvarsan or "606"— results which unfortunately have not been confirmed by a more extended experience. While there is no question of the incontestable efficacy of this remedy in causing the earlier lesions of syphilis to disappear, and even certain intractable lesions of a later stage, yet relapses are the rule and even more common, it would appear, than after the use of mercury. The effect of a remedy in preventing the dreaded manifestations of the disease upon the nervous system and the organs essential to life is the crucial test of its curative value. It will be necessary to wait several years before we can estimate its curative efficiency as determined by the ulterior evolution of the disease. There is reason to doubt whether any chronic infectious disease like tuberculosis, leprosy and syphilis can ever be expelled by therapeutic violence. The most refractory and difficult form of syphilis to treat is neurosyphilis, or syphilis of the nervous system. Neurosyphilis may give rise to a great variety of different types of disease, so great that the general practitioner can hardly bear them all in mind. Special methods of treatment are essential in these forms of syphilis. Consult Jelliffe and White, 'Diseases of the Nervous System' (3d ed., 1919).

SYR, or **SIR DARYA**, sēr-dār'yä, Turkestan, (1) A river (the ancient Jaxartes) rising in the Thian-Shan Mountains on the boundary of East Turkestan and flowing west and northwest into the Aral Sea. It traverses the districts of Ferghana, Samarkand and Syr Darya and has a total length of about 1700 miles. In its upper course it receives numerous tributaries. After leaving the mountain regions in a series of rapids it flows for the rest of its course over the vast arid plains of the Syr Darya district, where it is broad, deep and tranquil, but receives few affluents. It here repeatedly divides itself and numerous irrigation canals lead from it into the surrounding country. The river is navigable for 600 miles, but the proposed line of steamers has not yet been installed. (2) A district of Turkestan with an area of 194,853 square miles. The capital is Tashkend; pop. about 150,000. The population of the district is 1,990,000.

SYRA, sē'rā, Greece, (1) An island in the Ægean Sea, the largest of the Cyclades, 13 miles south of Andros, with an area of about 32 square miles. The surface is rugged and bleak and the coast indented by numerous bays and inlets. The diversified landscape includes fertile valleys with some barren patches. The chief products are wheat, barley, cotton, wine and figs, but crops are inadequate to the demand and provisions are largely imported. Syra remained neutral during the War of Independence, thus becoming an important centre of commerce. The climate is salubrious. Pop. 26,856. (2) Syra, or Hermupolis, the capital, is built in terraces rising from the bay. It is the seat of government for the Cyclades, the see of a bishop and residence of foreign consuls. Its trade with the Levant is considerable. It is the commercial emporium of the Ægean Sea, imports provisions, coal, etc., and exports emery, tobacco, sponges, valonia, etc. Pop. about 20,000.

SYRACUSE, sĭr-a-kūs, N. Y., city and county-seat of Onondaga County, situated on the New York Central and the Delaware, Lackawanna and Western railroads, almost exactly midway between Albany and Buffalo, 148 miles either way, in lat. 43° 9' W. The New York State Barge Canal reaches it through Onondaga Lake.

Topography.— The city is at the foot of the Onondaga Valley, through which and the city the Onondaga Creek flows into a lake of the same name north of the city, five miles long and one and one-half miles wide. The southern part is flanked by hills at the northern ends of the ranges on the east and west of the valley and extending considerable distance southward; while the northern part is upon ground which slopes upward from the Erie Canal to the northern boundary. There are several hills of volcanic formation and of geological interest. A considerable part of the city is situated upon silt brought down from the Onondaga Valley, to a depth at one point of at least 179 feet, as proved when at that depth a salt drill passed through a cedar log. Perhaps there is no section of the State of New York which possesses more of geological interest than Syracuse and Onondaga County, and this is certainly true of their Indian history. The streets are generally regularly laid out, though some of the principal streets have independent courses creating triangular divisions of blocks. Many are 99 feet in width, but the majority are 66 feet. There are 570 streets, with a total length of 250 miles. There are nearly 114 miles of paved streets, mainly with brick and asphalt, and 209 miles of sewers. The area of the city is 19.18 square miles.

Transportation.— Syracuse is an important railroad point, its roads being to its centre like the spokes of a wheel to the hub. Passenger trains to the number of 100 arrive in and depart from the city daily. Abundant freight facilities are offered by competing lines and important advantages can also be had from the improved New York State waterways. Diverging from the city are the following railroads: New York Central, West Shore, and Delaware, Lackawanna and Western. These roads not only thread some 20 counties in central New York, but several of them extend, with their connections, to the extremes of east, west, north and south. Of street railways, the trolley system embraces 95.72 miles of single track. This includes the mileage of track within the city of Syracuse, also to East Syracuse and Minoa, Eastwood, Liverpool, Solvay and Rockwell Springs. The New York State Railways operate to Utica and intermediate points; the Empire United Railways to Oswego and intermediate points; the Rochester and Syracuse to Rochester and points beyond, such as Buffalo and Lockport. All these lines carry freight and express. Motor truck lines operate from Syracuse to Utica, Watertown, Oswego, Auburn, Cortland and Rochester.

Commerce and Industry.— Syracuse ranks fourth among the cities of the State in the number and variety of its manufacturing plants; there are 760 industrial establishments, with an approximate invested capital of $63,957,000, and an annual production valued at $52,226,000, employing 25,000 persons. The manufacture of typewriting machines has taken on large proportions, the combined interests representing at least $8,000,000 in popular value. The product is large and constantly increasing. Automobiles are produced in large numbers, and among other manufactured articles are soda ash, tool steel, candles, automobile gears, farming implements, tools, clothing, chinaware, furniture, cement, chemicals, mining machinery, etc. The former leading manufacture of salt is still carried on at the brine springs on the shores of Onondaga Lake, and the extensive chemical works of the Solvay Process Company employing 5,000 hands are in a western suburb. (See *History* in this article). The printing industry is also extensive, more than 60 newspapers and periodicals being published, several of them devoted to the arts and sciences. The wholesale trade supplies hundreds of small dealers in the surrounding country in a radius of many miles. The retail trade involves an area of 38 mile radius and conservatively speaking brings 5,000 shoppers to the city each week.

Banks and Banking.— Six banks have a combined capital of slightly more than $6,600,000 with a large surplus. Two savings banks have 85,000 depositors and $48,000,000 of assets.

Buildings.— The business section is compactly built up of brick and Onondaga limestone mainly; there are a number of exhibits of present-day architecture and construction, such as the Onondaga County Savings Bank building, the University buildings, City Bank building, University Club, Young Men's Christian Association, Keith Theatre building, First Trust and Deposit building, Syracuse Trust Company, the Hunter-Tuppen Company and

Dey Brothers and Company's department stores, the high schools, courthouse, library and others. There are many stately and handsome business and public buildings, and fine private residences are seen in large numbers on all of the principal avenues. James street, it is very generally conceded, is second to no avenue in this country in point of attractiveness. The buildings of the Syracuse University, particularly the John Crouse College of Fine Arts, are all models of good architecture, and the Hall of Languages is a fair example of the excellence of Onondaga limestone, which exists in such vast quantities for building purposes.

Education.— The public schools are under the direction of eight commissioners, who appoint a superintendent at a salary of $4,000 per year. There are 38 public school buildings, having a valuation of $3,444,838. The number of pupils registered in the public schools for the year ended 1 July 1918, was 22,344, and in the high schools 3,358. The buildings are of brick, substantially constructed and supplied with the most modern sanitary appliances and heating apparatus. The course of study is according to the most advanced ideas, and a graduate of the high school is quite as well equipped as were graduates of most colleges half a century ago. Teachers' meetings are held monthly under the direction of the superintendent, not only to preserve uniformity in the system, but also for the instruction of teachers in their general as well as special duties. The Syracuse University (q.v.), embracing the colleges of liberal arts, fine arts, law, medicine, forestry and applied science, is situated on the highlands in the southeastern part of the city and has an ample campus of 100 acres. The property, including endowments, is valued at $3,156,711. There are 3,540 students in attendance; the professors and instructors number 344. It is under the control of a chancellor and board of trustees and allied religiously to the Methodist Church, though very liberal in this respect. The library comprises over 99,000 volumes and 43,000 pamphlets. An observatory is one of its essential fixtures. In the tower of the buildings of the College of Fine Arts is a chime of bells, and on an upper floor in the Hall of Languages building the Central New York Weather Observation Bureau is located and maintained by the United States government. All of the athletic sports are maintained, and the secret societies all have fine fraternity houses. There are 12 parochial schools and two non-parochical under Roman Catholic control, with 122 teachers and 5,400 pupils. They are under the general supervision of the bishop of the diocese, and are mainly intended for academic instruction.

Libraries.— The Syracuse Public Library system including three branches and 34 stations centres in the Carnegie Building which was completed in 1905 at a cost of $268,000. The library contains about 140,000 books and in 1918 had a circulation of 556,437 among 43,921 borrowers. The main library is the centre of many public activities, including the Americanization work of the city. The servce of the library is free. The library of the Court of Appeals in the Court House is one of the three best libraries of the State, by which it is maintained. The general library of Syracuse University is housed in a building donated by Mr. Carnegie and is rich in certain lines of research material. The State College of Forestry connected with Syracuse University maintains a special library for forestry students. The College of Medicine has a well-equipped library for physicians and surgeons.

Religion and Charity.— Of churches and missions there are 116, of denominations as follows: Methodist, 23; Roman Catholic, 17; Presbyterian, 12; Baptist, 10; Episcopal, 8; Lutheran, 8; Jewish, 7; Congregational, 6; Evangelist, 2; Reformed, 2; Church of Christ, 1; Unitarian, 1; Universalist, 1; Scientist, 1; Seventh Day Adventists, 1; missions, 16. There are 13 cemeteries, of which Oakwood stands first because of its rolling surface, its shading oaks, impressive entrance way and costly memorials. Burials were made within the present enclosure of one of these cemeteries nearly a century ago. There are five principal hospitals, namely, the Good Shepherd, Saint Joseph's, Homeopathic, Memorial and Crouse-Irving. Each hospital has its own training school for nurses. The Syracuse Free Dispensary affords medical relief to suffering people and ministers to the need of more than 3,828 people annually, giving 20,373 treatments and 8,584 prescriptions. It is wholly supported by voluntary contributions. The Onondaga Orphan Asylum, the Saint Vincent De Paul Orphan Asylum and the House of Providence are the three principal homes for orphans or homeless children, the first being under Protestant patronage, the others having Roman Catholic support. The State Institution for Feeble-Minded Children is situated on an elevation on the western boundary of the city and is under the supervision of a superintendent and board of trustees. A small farm is connected with the institution which not only gives easy employment to a certain class of inmates, but produces a considerable quantity of supplies. The buildings are of good architecture and the grounds in their vicinity covered with a variety of shade trees and shrubs. The unfortunate children are of all ages, and while the condition of the mentality of most of them is hopeless a few manifest some improvement after long and patient effort on the part of the teachers.

Public Utilities.— Water is brought from Skaneateles Lake, 20 miles away, at an elevation of 440 feet above tidewater. The lake is 16 miles long, averaging 2 miles in width and is mainly supplied by springs. The immediate supply is from a reservoir of 17 acres 220 feet above the main level of the city, which give a hydrant pressure of 95 pounds. Almost every part of the city is supplied; the water bureau bears the cost of connections between mains and curbs. There are 226 miles of mains and 3,042 fire hydrants. The bonded debt for the waterworks is $4,100,000. The fire department comprises five gasoline pumping engines and hose carts; two triple gasoline pumping engines and chemical hose cart; four steam-fire engines — tractor drawn; six gasoline combination chemical hose wagons; two horse-drawn combination hose wagons; four hook and ladder trucks — tractor drawn; one hook and ladder truck, horse drawn; one water tower;

four district chiefs' auto runabouts; one chief's car; one motor-supply wagon; one horse-drawn supply wagon. It is under the command of a chief, assistant chiefs and the respective captains of the several companies. The police force comprises 250 men and a special force of detectives, all under officers of grades from chief to sergeant. The inspections and parades of the body show good drill and discipline and the force is rated as of the best. The sanitary conditions are under the observation of a board of health, the health officer being salaried. Garbage is collected by day labor and is burned in a crematory at a certain contract price. The mortuary statistics show an average annual death rate of 13.1 per 1,000 of population.

Government.— The municipal government is organized under the uniform charter for cities of the second class of the State, the executive and administrative control being vested in a mayor and common council composed of 19 aldermen, representing the same number of wards, and with the mayor elective every two years. A president of the common council, comptroller, city treasurer, four assessors and eight members of the board of education are also elective. The commissioner of public safety, having control of the fire, police and public health departments and of the bureau of water; the commissioner of public works, the city engineer, the corporation counsel and commissioner of charities are appointees of the mayor. The mayor, corporation counsel, commissioner of public works, comptroller and city engineer constitute the board of contract and supply, which makes all municipal contracts and furnishes all supplies to the various departments. The mayor, president of the common council, corporation counsel, comptroller and city engineer constitute the board of estimate and apportionment, which makes up the annual expense budget and fixes the salaries of city officers, subject to the action of the common council. The Municipal Court is presided over by two judges and its cases often number more than 3,000 a year. It is invested with considerable power and authority.

History.— The territory now occupied by Syracuse, also territory both north and south of it, was known to white men, as early as 1620, by the French, and subsequently by the English, who came up what are now the Oswego and Seneca rivers through Onondaga Lake, from Lake Ontario, and left present traces of their invasions throughout the central and northern parts and some in the southeastern part of Onondaga County. Possession of the territory was seriously and successfully contested by the Indians (mainly the Onondagas), and here and there abundant evidence of the fierceness of battles has been shown by the quantities of stone arrow points and hatchets found. The Iroquois were more or less involved in the invasions, but the brunt of resistance was with the Onondagas, who were in real possession of the lands. The League had been formed probably about 1580, which bound the Six Nations (q.v.) included in it to mutual assistance and some was given. The council fire was with the Onondagas, they being the strongest of the Six Nations, and it has always remained with them. By treaties with friendly native white people and the State, the Onondagas from time to time were induced to surrender their possessions, until finally they were allotted a "reservation" a few miles south of the city where they were to occupy permanent homes and makes the best of the rocky hills constituting most of their land. There the Onondagas, to the number of about 425, still exist, wedded to their habits and traditions. Many of them speak English and a few attend the Methodist or Episcopal mission and a goodly number of the children attend a school supported by the State. The religion of most of them is essentially pagan, and many of those who profess to be converted to the Christian faith find it difficult to divest themselves of pagan leanings. When emigrants began to come to the locality from New England as early as previous to the Revolutionary War, they were received kindly by the Indians, even if they recognized the fact that they were in a sense trespassers, so that when the county was created in March 1794 there was a considerable settlement scattered over most of it. As early as 1789 the Salt Springs, long known to the Indians who had produced salt from them, became known to white settlers, and they, in a crude manner, began the manufacture of salt and sent quantities of it to the Eastern market. The State assumed control of the Springs in 1797 (20 June) and leased lots and privileges to whomsoever might desire them; during the remainder of that year 25,474 bushels of salt was produced and inspected by the State officials, the lessees being required to pay a royalty or tax per bushel produced. The annual product increased rapidly so that in 1810 452,050 bushels were made; (1820) 458,329 bushels; (1830) 1,435,446 bushels; (1840) 2,621,-305 bushels; (1850) 4,268,919 bushels; (1870) 8,748,115 bushels. About 1890 the annual product began to diminish, mainly because of competition at Warsaw and in Michigan. It was estimated that at one time the Springs gave employment, directly and indirectly, to one-half of the population of the city; but with their decadence, more and more attention was given to the development of manufacturing industries, which have now become very numerous, having vast capital and being the main support of the wage-earners of the city. Principal among these is the Solvay Process Company, whose extensive works are situated just across the west line of the city, on the State Barge Canal and New York Central Railroad. The company also has branch works at Delray, Mich., near Detroit, which have a capacity of about 500 tons of alkali per day. The amount of capital invested at Syracuse is estimated at $6,000,000 and about 5,200 men employed. The principal products are soda ash, bicarbonate of soda, caustic soda and crystals, of which the daily output is estimated at 1,000 tons. This company also makes coke, tar, ammonia, carbolic acid, picric acid and some other coal-tar products. Here again salt becomes both indispensable and profitable, for it is an essential element in the production of alkali, by the so-called ammonia process, which is employed here. The company obtains its brine from wells which it sunk near Tully, some 20 miles south of the city, and brings the brine to its works through iron pipes. It was in the sinking of these wells that the source of the brine which for so many years has been utilized in Syracuse was found, in a mass of solid salt, extending, no doubt, for many miles east and west. It was found necessary to discharge fresh water into some wells, when it would become saturated and then pumped from other wells to the pipes leading to the works. Experiments made at this point in the belief that the discovery would verify the source were justified. The supply is supposed to be absolutely inexhaustible, but singularly enough the brine is not suitable for the best quality of salt, which is still produced from local wells to the extent of nearly 2,000,000 bushels per year. The company procures its limestone from Split Rock, several miles southwest of its works, bringing the material in by means of large buckets suspended on overhead wires and moved by steam power. They run in close connection and continuously and are capable of transporting 1,000 tons in 12 hours. A vast excavation has been made in the great layer of rock, of much breadth and thickness. Much of the building stone came from this quarry before it was converted to its present purpose. The «waste» product of the works has been used to fill surrounding low lands until hundreds of acres have been covered to great depths and places of deposit are now so limited that Onondaga Lake will henceforth be used as the place of discharge. The material is white and like marl and possesses no sustenance for vegetation.

The State Fair is always a feature of the social life of Syracuse, as well as entertainment for thousands of people from abroad. The grounds, situated on the western border of the city, consisting of 100 acres, quite covered with buildings for various purposes, embracing a very costly speeding track, are owned by the State, under an act of the legislature making the establishment permanent. Several clubs of large membership, the Century leading and much the oldest, are centres of sociability and places for business conferences among men, while there is one woman's club, the Kanatenah, and many other social organizations.

Population.— When the county was created in 1794 the county-seat was established at Onondaga Hill, four miles southwest of the present city centre; but the construction of the Erie Canal and development of the salt works caused a change of the county-seat to Syracuse in 1827, when the population of the village created in 1825 had increased to about 2,000 and to 6,829 in 1830. The population of Syracuse has increased steadily and very rapidly, as follows: 1850 (city incorporated in 1848), 22,271; (1860), 28,119; (1870), 43,051; (1880), 51,792; (1890), 88,143; (1900), 108,374; (1910), 137,249; (1919), estimated 160,000.

FREDERICK E. NORTON,
Secretary, Syracuse Chamber of Commerce.

SYRACUSE, ancient **SVIAGOSA,** Sicily, a city and seaport on the southeastern extremity of the island, 80 miles southwest of Messina. It has an excellent harbor but has greatly declined from its ancient magnitude and splendor when it had a population of 500,000 inhabitants. Ortygia, once an island, now a peninsula, at the southeastern portion, contains all that remains of the ancient city. Here are seen ruins of a Greek temple, dedicated to Diana or Apollo, a castle, remains of ancient baths and mediæval palaces, a cathedral built within the columns of a Doric temple to Diana or Minerva. There is also a museum containing valuable antiquities, coins, etc. In the southern portion of the town is the fountain of Arethusa, called la Parruca by the inhabitants, whose water became salty after an earthquake. Parts of the walls of the ancient city are preserved, which formerly enclosed the entire city on the mainland, also of the two great aqueducts; a Roman amphitheatre of the age of Augustus; a Greek theatre of the 5th century B.C.; a temple to Ceres and extensive catacombs; the massive towers of the fortifications of the castle Euryalos in the northwest, subterranean passages hewn through solid rock, etc., with endless ramifications in all directions. The Ear of Dionysius, a deep grotto with a wonderful echo, is 170 feet long, 60 feet high and 20 to 35 feet wide. Syracuse was founded by Greek Corinthians in 734 B.C. Its early political history is obscure; it is known that it thrived and itself sent out other colonies, becoming the largest and wealthiest city of the Old World. It had at one period a democratic government. In 215 B.C. it was invested by the Romans and defended by Archimedes, resisted for three years, but finally surrendered 212 B.C., remaining in possession of the Romans till the downfall of their empire. Theocritus and Archimedes were natives of Syracuse. An increasing export trade is carried on in olive oil, lemons, oranges, etc. Pop. 27,352. Consult Baedeker, C., 'Southern Italy and Sicily' (16th ed., Leipzig 1912); Freeman, E. A., 'History of Sicily' (4 vols., Oxford 1894); Cavallari and Holm, 'Topografia archeologica di Siracusa' (Palermo 1883, 1891).

SYRACUSE UNIVERSITY, located at Syracuse, N. Y., was chartered in 1870. The collegiate department, which was first opened in 1871, was the continuation of Genesee College, founded at Lima, N. Y., in 1849. In 1872 the Geneva Medical College, founded in 1835, was moved to Syracuse and became the College of Medicine of the university and in 1873 the College of Fine Arts was organized. This latter was an experiment in American education and has proved eminently successful. The College of Law was added in 1895, the College of Applied Science in 1901, the Teachers' College in 1906, the Library School in 1896, the Summer School in 1901, the Graduate School in 1911, the New York State College of Forestry in 1911, the College of Agriculture in 1910, the School of Oratory in 1914. The Hospital of the Good Shepherd became a part of the university in 1915. The College of Liberal Arts offers one course leading to the degree of A.B. The course includes certain required studies, one major subject (six hours a week for two years), one minor subject (three hours a week for two years) and free electives to complete the required number of hours. Instruction in Bible study is a part of the curriculum but the courses are elective. The Graduate School provides for work leading to the degrees of A.M., M.S. and Ph.D. The College of Fine Arts offers a four years' course in architecture, leading to the degree of B.Ar., a four years' course in painting, leading to the degree of B.P., four-year courses in piano, vocal, organ and violin, leading to the degree of B.Mus., a course in *Belles-lettres* leading to the degree of B.L. These courses include instruction in general history, philosophy, etc., as well as in theory, history and practice of the arts. The College of Medicine offers a four years' course, leading to the degree of M.D., and the College of Law a three years' course, leading to the degree of LL.B. Two years must be spent in a college of liberal arts before the medical course is undertaken and one year before the course in law can be undertaken. Students can so arrange their electives as to complete the college and medical courses in seven years, the college and law courses in six years. The College of Applied Science offers courses in civil, electrical, mechanical and chemical engineering, leading to the degrees of C.E., E.E., M.E. and B.S. in chemical engineering. The students maintain literary, historical and scientific associations and the Greek-letter fraternities are well represented. Physical training is a regular part of the collegiate course and there is a general interest in athletics. All business of the athletic teams is in the hands of the athletic governing board, which includes representatives of the faculty, the students, the alumni and interested business men of the city. Dormitories for women include Winchell Hall, Haven Hall, Reid Hall and eight cottages. Sims Hall is the dormitory for men. Many of the students live in their fraternity houses. The campus contains 100 acres situated on a hill overlooking the city and surrounding country. The university farm is located a mile from the campus. The buildings of the university include (1916) the Hall of Languages, the Charles Demarest Holden Observatory, the Carnegie Library, the John Crouse Memorial College (for the College of Fine Arts), the College of Medicine, the College of Law, the Archbold Stadium and Gymnasium, the Women's Gymnasium, the Esther Baker Steele Hall of Physics, the Lyman Cornelius Smith College of Applied Science (containing shops for metal and wood work), the Administration Building, Lyman Hall of Natural History, Bowne Hall of Chemistry, New York State College of Forestry building, the Photography building, the free dispensary, Margaret Olivia Slocum Teachers' College, the Joseph Slocum College of Agriculture, nearly a block of hospital buildings and the University block, one of the largest commercial buildings in the interior of New York State, erected for investment purposes. In 1902 the United States government established a weather observing station with complete equipment in the Hall of Languages. The library contains over 100,000 volumes, including the general library, the historical library of Leopold von Ranke, purchased in 1887 and other special libraries in economics, science, etc. The Syracuse City Library and the law library of the State Court of Appeals are open to students. The students number over 4,000, of whom 1,500 are in the College of Liberal Arts, and the faculty, 325.

JAMES R. DAY,
Chancellor.

SYRIA, a country of western Asia, geographically and anthropologically a kind of peninsula of the Mediterranean, forming a bridge between north and south, connecting Asia Minor and Mesopotamia with Arabia and Egypt, and bounded by the sea on the west and by the desert, only some 60 miles inland (at the narrowest part) on the east. The name «Syria» is rather a geographical expression than a geographical fact, for the region which bears that name on our maps has been arbitrarily thus delimited by modern (Christian) geographers. The name was originally of much wider application than it is now, while even to-day, strictly speaking, it includes Palestine. The subjects of the Assyrian Empire, from the Black Sea to the Mediterranean, were known in ancient times as Assyrians or, in the abbreviated form, Syrians. These two names came at a later period to have different applications: Whereas «Syria» once meant all the Assyrian Empire and also Mesopotamia, it became usual with the Greeks and Romans to apply that name to the more western of these regions, but including Palestine. Later on, Christian sentiment created imaginary boundaries out of existing landmarks and separated the «Holy Land» from a part of itself, a proceeding that gave birth to the prevalent erroneous impression that Syria and Palestine are two distinct countries. Geographically and geologically they cannot be separated; the mountains of Palestine, both on the western and eastern sides of the Jordan, are, respectively, the terminations of the Lebanon and Anti-Lebanon Mountains. The Jordan Valley is a continuation of the Buka Valley, and three out of the four sources of the river Jordan itself are in Syria. The district we describe as Palestine no longer means as once «the land of the Philistines,» and always has included much which the Philistines never held; it was never entirely held by the Hebrews for any length of time. Its boundaries correspond with the idealized limits of Canaan as divided among the 12 tribes, with the possessions of the Hebrew kings in the days of their greatness, and with the Palestine of New Testament history.

Syria, under Turkish rule, was divided into four vilayets and two «independent sanjaks» as follows: Aleppo, 33,430 square miles, pop. 1,500,000; Syria, 37,020 square miles, pop. 1,000,000; Beirut, 6,180 square miles, pop. 533,500; Lebanon, 1,190 square miles, pop. 200,000; Zor, 30,110 square miles, pop. 100,000; Jerusalem, 6,600 square miles, pop. 341,600. The last two are «sanjaks»; the whole of Palestine was included in that of Jerusalem and the vilayet of Lebanon. Total area, 114,530 square miles; pop. 3,675,000. Of the area, not more than 12,000 square miles comprise Palestine, to which also belong between 600,000 and 700,000 of the population. The ancient inhabitants called the country «Aram,» of which name the Biblical «Syria» is a translation. The Arabs called it esh-Shâm (the left) north of Mecca and Medina; and Yemen (Yamin) to the right of those cities. Damascus, believed to be the most ancient city in the world, was the capital of the Aramaic kingdom. While the modern inhabitants use the ancient inclusive name Suriyya, the Arabs call both Syria and Damascus esh-Shâm; the Turkish name is Suria (also Shâm); the Persians call it Soristán.

Topography.— Regarded in the ordinary sense of the name, Syria is the long and narrow district on the eastern shore of the Mediterranean, extending from the Taurus range on the north, separating it from Asia Minor, to Egypt on the southwest, between 36° 5′ and 31° N. lat. and long. 33° 30′ and 39° E. The Euphrates forms the northeastern border; the Syrian Desert the eastern limits, and Arabia on the south and southwest. The Mesopotamian plains are separated by the desert from the Mediterranean coast region, which stretches nearly in a straight line from the Sinai Peninsula northward to Anatolia. The desert forms a chalk and limestone tableland rising gradually to an altitude of over 2,000 feet above sea-level, stretching away southward into the Arabian Peninsula, but on the west sinking abruptly down to the long, deep and narrow depression of El-Ghor, which forms the eastern limit of the southern section of the coast region known as Palestine. Farther north the desert merges imperceptibly in the plains of Damascus and Aleppo and thus presents no natural well-defined limits to Syria on the east. Elsewhere the boundaries are sufficiently clear. The total length north and south is variously estimated at between 370 and 430 miles, with a mean breadth of 100 miles, narrowing in the south to 60 and expanding northward to 150 miles. Palestine is cut off by the Lower Orontes (Nahr el-Asi) and Mount Hermon from Syria proper, measuring from this point to the southern end of the Dead Sea (Bahr Lût, i.e., Lake of Lot) about 160 miles, with an average breadth of 70 miles. Geologically, Syria is a great desert-plateau only differentiated from the North Arabian Desert by a picturesque mountain-wall, split in the north into two parallel chains — the Lebanon and Anti-Lebanon, the latter falling gradually northward down to the plains of Upper Mesopotamia, while the former is continued by the less elevated Jebel-Nusarieh as far as the plain of Antioch, about the 36th parallel. North of this plain the Jebel-Nusarieh is continued by the Giaour-Dagh and Akma-Dagh to the Taurus above the Gulf of Alexandretta. These ranges condense the vapors from the sea and remain snow-clad till late in summer, giving the 10 to 16 miles' breadth of the Syrian seaboard its luxuriant subtropical vegetation and Palestine its fertility as far as its southern borders. The Lebanon range runs for about 90 miles southwest and approaches at some points to within 8 or 10 miles of the Mediterranean, presenting to seaward the appearance of bare, rocky walls surmounted here and there by a few snow-decked peaks, Dahr-el-Kodib (10,200 feet) and Jebel-Makmal (10,020 feet). From these is derived the name of Lebanon (white mountains), which was already current in the time of Moses. Despite its rugged appearance the Lebanon contains many fertile slopes and valleys, well cultivated and thickly populated. Eastward it is cut off from the Anti-Lebanon by the still more fertile plain of the Beka'a (Coele-syria), whose bald, rocky ramparts present more varied outlines than the coast range. The southern extremity of the Anti-Lebanon rises in the Jebel-esh-Sheikh (Mount Hermon) to an altitude of nearly 10,000 feet, the culminating point of the Syrian highlands, about 30 miles southwest of Damascus, the capital of Syria. The offshoots of the Lebanon range also stretch southward, with slight interruptions, throughout the whole of Palestine. Where it enters that country the upper part approaches the sea and at Mount Carmel sends forth a lateral branch, which farther south is separated from the sea by a fertile plain. Within this region are situated the oldest and most famous places in Palestine, including the mountains of Naphtali, and of Ephraim and Judah. It is this range which prevents the Jordan from flowing toward the sea and compels it to follow a southern course until it loses itself in the Dead Sea. Excluding the southeastern flanks of Hermon, both the Lebanon and Anti-Lebanon ranges are of limestone formation; the former is a single ridge deeply marked from the effects of erosion by water, while from the latter five ridges diverge northward. The spaces between them is taken up by a plateau of from 4,000 to over 5,000 feet above sea-level. The depression of El-Ghor, referred to above, is the deepest in the earth's crust, falling about 13,000 feet below sea-level, or more than 4,000 feet lower than the Beka'a plain. The four main streams — the Jordan, Leontes, Orontes and Abana — rise in the neighborhood of Baalbek, under the 34th parallel. They flow in four opposite directions, south to the Dead Sea, southwest and northwest to the Mediterranean, and east to the Bahr-et-el-Ateibeh, some five hours' journey beyond Damascus. The Euphrates, breaking the Taurus in a succession of cataracts and rapids, flows south and southeast, separating Mesopotamia from Syria and the deserts of Syrian Arabia, and is joined by the Tigris at Kurna. In the course of the Jordan are the lakes of Merom (El-Huleh) and Tiberias, and at its mouth is the Dead Sea. There are few perennial streams in Syria; the rain is quickly absorbed by the stony ground. Some of the old river-beds (wâdy) are deeply eroded. The mountain chains divide Syria into three regions — a western, consisting of a narrow belt of lowland extending between the sea and the mountains, sometimes sandy, but generally fertile; a central, occupied by the principal mountains of the chain; and an eastern, consisting for the most part of a bare, arid, sandy plateau, occasionally relieved by a few oases. Above all towers Mount Hermon, visible from almost all parts of Syria and forming a valuable landmark for the guidance of caravans. The «Little Ghor» or plain of Gennesareth stretches west of Lake Tiberias. On the eastern border of Syria extends the interior of the country, a fertile steppe, which when artificially watered yields the most luxuriant produce. This region, which is called the desert on account of its lack of water, stretches at a mean level of 1,900 feet to the vicinity of the Euphrates. It is inhabited by independent, nomadic Bedouins and frequently traversed by caravans. Beyond the Jordan, not far from Mount Hermon, rise the volcanic hills of Tulûl. To the south of Damascus lie the ancient wheat-bearing plains of Haurân and the mountains of that name, a region in which numerous ancient inscriptions are to be found. Farther south extend the mountains of Gilead, partially wooded. The mountains of Moab form an extensive tableland separated from the desert toward the east by a low range of hills. Between the Haurân and the Oasis of Damascus there stretches a broad expanse of volcanic hills, the Eastern

Trachonitis (Tulûl-es-Safa), toward the northern verge of which stand the stupendous ruins of Palmyra (Tudmur), supposed to have been built by Solomon. The Ala region between the vilayets of Damascus and Aleppo forms an extensive basaltic upland tract for many miles east of the Orontes. Here are the ruins of many ancient cities. In the extreme north the great inland plateaux of Aleppo, Umk and Aintâb occupy all the space between the bend of the Euphrates and the coast range, and are thickly inhabited by Turkoman and Armenian agriculturists. This region marks the extreme limits of both of these races toward the southwest. West of the Umk plateau lies the Bahr-el-Abiad (Lake of Antioch), a fine sheet of water, eight miles by six, formed by the junction of several steppe streams and draining to the Orontes.

Flora and Fauna.— Vegetation is much more varied and luxuriant in the north than in the south. The fertility of the soil of Syria is extolled by many ancient writers as well as in the Bible. Even the Syrian «desert» consists, not of sand, but of excellent soil, which after the early rain produces a rich crop of grasses and flowering herbs, affording most valuable pasture. The whole coast-district belongs to the region of the *Mediterranean Flora,* which extends around the basin of that sea, reaching inland as far as the lower hill country. This vegetation is, therefore, similar to that of Spain, Algeria and Sicily, with some modifications in the direction of Egypt. Among the principal products are corn, cotton, fruit in almost endless variety, indigo, sugar cane, grapes, oranges, mulberries, olives and tobacco. The tobacco especially of the Latakia district facing Cyprus is noted for its powerful, aromatic flavor. What still remains of the historic cedars of Lebanon is now found only at a solitary spot a few miles below Tripoli; farther south, the rose of Sharon is still cultivated. Inland, as the higher ground of the interior is approached, the vegetation changes to that of the Oriental type, a great variety of species with a dry and thorny undergrowth and stunted trees. The vegetation of the Jordan Valley somewhat resembles that of Nubia on the verge of the tropics. Considerable quantities of raisins are grown round Damascus and Es-Ṣalt. Pistachios are raised in northern Syria and nuts in central Syria, while in the desert near Damascus and east of the Jordan *kali* or saltwort is grown extensively. The *gall apples* produced by the oaks of the north are largely exported to Europe for dyeing purposes. Other products are licorice, alizari or madder, the bark of the pomegranate tree (used in tanning) and sumach, figs, citrons, pomegranates and almonds, cucumbers, onions, artichokes, egg-plant and truffles. While the cedar and cypress is growing rare, the pine is common; tamarisk and the poplar willow are frequently met with, as well as the terebinth or turpentine tree and the Valonia oak.

Among wild animals the chief are the Syrian bear, the hyæna, jackal, boar, panther and ounce. A connecting link between the domestic and the wild animals is formed in Syria by the dog and the cat. Each town and village is infested with masterless dogs who subsist on the refuse. There are two species of the fox and the wolf is not uncommon in the Lebanon Mountains. Gazelles are hunted in eastern Syria. The numerous caverns harbor several varieties of bats; there are four species of hares and numerous rodents, among them the graceful jumping mouse of the desert. The domestic animals include a small but hardy race of horses; camels and mules are also used as beasts of burden, especially in the trade between the coast and the interior. Fat-tailed sheep are plentiful, but the transplanted Angora breed soon degenerates. Pigs are practically unknown. The domestic hen is very common, but ducks are only to be found in a wild state. Partridges occur on all the hills and quail in the cornfields of the plains. The eagle and vulture are found about the Dead Sea, while storks, cranes and becassins frequent different localities. Among the few singing birds the nightingale (bulbul) is the most notable. Fish abounds in the Jordan and Lake Tiberias as well as in almost all the perennial streams. Both Syria and Palestine are rich in «creeping things» and insects. Crocodiles have been seen (though very rarely) in the marshes between Haifa and Kaisariyeh on the Palestine coast, where the climate resembles that of the Nile Delta. The common chameleon, the harmless little gecko and numerous snakes, many of them poisonous, are found, as well as the land tortoise and the small-tailed water tortoise. Among the mountains occurs the dark-colored khardon of the Arabs, with its prickly tail and back. Mosquitos, wasps, wild bees, hornets, grasshoppers (or locusts) are common. Locusts are the plague of farmers, often devouring whole crops; they are eaten only by the Bedouins. North of Beirut sponges are found on the coast, where there is a large fishing industry.

People.— The inhabitants of Syria present a conglomeration of races united by one common language, Arabic. They are mainly members of the great family named Semitic, a purely conventional term used to designate the group of peoples who are ethnographically allied by their languages — those of a peculiar construction and similar in character to the Hebrew. The dwellers of Syria consist chiefly of descendants of the ancient Syrians, Arabs, Turks, Greeks and Jews; among the most celebrated tribes are the mysterious Druses and Maronites, while several other nomadic tribes such as the Turkomans, dwell in the north; Kurds, on the banks of the Euphrates, and Bedouins in the Syrian Desert. Greeks, Romans and European crusaders have all blended with the ancient Semitic stock to produce the Syrians of to-day.

From the most remote times Syria was inhabited by Semitic stock; the Philistines and Hittites were the only exceptions. The former, whatever their origin, were soon merged with the primæval inhabitants, adopting both language and religion. In like manner the non-Semitic branch of the Hittites was absorbed. The Arab invasion in the 7th century introduced a new factor. All the people of Syria, as well as Egypt and Mesopotamia, became unified by a vigorous conquering race which left an ineradicable mark on the language and culture of the Christian and Jewish natives, to whom they were racially related, though of a different faith — Islam. That religion was even an eclectic compound of popular Christianity and Judaism. Their language, Arabic, was most properly spoken in all Syria, while an Arabic Christian dynasty had existed in Damascus even before the invasion. These vigorous sons of the desert brought about a double process of assimilation. They learned eagerly from the natives, from the Persians and the Greeks. They were apt pupils who in many cases were not only able to improve upon the wisdom of their teachers, but also to absorb and mold all this foreign learning into the Arabic language, even to the extent of applying Arabic equivalents for the technical words of science or philosophy instead of using the Greek forms. That process of acclimatizing foreign ideas and culture is still prevalent among Syrian writers to-day. The Mohammedan invaders absorbed many of the old customs and religious traditions of the soil and adopted the old shrines of saints in different communities and gave them Mohammedan names. Through their language they impressed their own poetry, national heroes and saints upon the people with the result that the most modern Syrian writers echo the voices and thoughts of Arabian bards and philosophers. In the Syria of to-day the Christions, Mohammedans and Jews possess a common heritage of proverbs, legends, parables and superstitions. Indeed, it is no exaggeration to say that the modern Syrians are one people with the same fundamental outlook on life, despite their different religions and sects, characteristics, clannish traits and various dialects. In this happy blending of races the natural endowments of the people are favorably exemplified by the Christian section of the population. They form a highly intelligent people with a remarkable capacity for adopting European ideas. The admixture of Greek and Arabic blood seems not to have impaired the good qualities of their Phœnician and Aramæn ancestors. The inhabitants of the coast districts are still Phœnicians in their enterprising spirit, commercial skill and love of travel. In Marseilles, Liverpool and Manchester, Syrian merchants are settled who promote the interests of their native land, extending their trading relations to Scandinavia and North America. Intelligent industry is responsible for the prosperous condition of the Beirut Christians. Here proverty is rare, and everyone is engaged in some branch of industry or trade. Family life is simple and patriarchal. The women are thrifty housewives and devoted to their families, associating little with the outside world. The Druses and Turkomans (qq.v.) are alien races; the old Syriac or Aramaic tongue is spoken only by the Nestorians of Kurdistan; the Turkish officials and soldiers under the old régime spoke their own language.

Education and Religion.— Under Turkish rule elementary education was nominally compulsory for all children of both sexes, while the Ministry of Public Instruction provided for the inspection of schools maintained by non-Moslem communities. In Syria there are many native schools and other educational institutions maintained for foreign missions. In the numerous girls' schools instruction is limited mainly to the study of French and English. The «Sisters of Charity» conduct an excellent training school where woman's work is taught and native teachers are trained. The rival houses of the «Sisters of Nazareth» and of the «Prussian Deaconesses» are highly praised for their labors, while the American missionaries aim especially at practical objects of education.

In religion the bulk of the inhabitants are Mohammedans; the Christians make up one-fifth of the total, and are divided into Orthodox Greeks, United Greeks, Maronites (q.v.), Roman Catholics, Nestorians and Protestants. The number of Jews is estimated at about 200,000. Protestantism is making rapid progress in Beirut (where that denomination maintains a fine church, several schools and a printing establishment) and in the Lebanon. In the latter region also dwell some Bedouin «Ishmaelites,» descended from the murderous sect of «Assassins,» who have given a familiar word to most European languages. Quite recently large settlements of Moslem Circassians, driven from their homes by their objection to living under Christian Russia, have been established east of the Jordan.

Towns.— In Syria many of the most venerable cities in the world, such as Damascus, Aleppo, Emessa, Beirut and Jerusalem, still flourish and retain their ancient names in modified but recognizable forms. Tyre, Palmyra, Baalbek and some other famous places have either disappeared or shrunk into obscure hamlets. The principal seaports of Syria are still found on the coast of what was once Phœnicia, the home of the most famous navigators of antiquity. Beirut is the chief port and next to Smyrna the largest and most flourishing seaport in the Levant. Two other northern ports are Latakia and Tripoli; the southern ports, Sidon, Tyre, Acre, Cæsarea (Kaiseriyeh) and Ascalon, have lost their trade and importance during the centuries since the Crusades and are now little more than fishing villages with small local traffic. Jaffa (Joppa) has recovered all its former prosperity owing to the orange industry and the Jerusalem Railway. Alexandretta (Iskandrun), in the extreme north, contains the finest harbor on that coast, but is the most fever-stricken spot in that region. Swedea (Seleucia), about 30 miles south of Alexandretta, also has a fine natural harbor. A peculiar feature of this district is that practically all the inhabitants are afflicted with the «Aleppo Button» or the «Baghdad Date Mark,» each the result of a boil that always lasts a year before healing. Europeans contract these diseases often during only a few days' stay. Sidon (q.v.), now called Saida, is of considerable historical interest.

Communications.— Of the three great routes which have been the main thoroughfares between Europe and Asia — namely the Red Sea, the Euphrates Valley and the Caspian — the Euphrates is the most ancient and most direct. From remotest antiquity it has been the main channel by which the riches of the East have flowed to the West, and to possess this Indo-Syrian trade route has been the desire of all great European powers, for the region it traverses is the pivot of European domination in Asia. The first great traffickers between East and West were the Phœnicians, whose success in commerce was probably largely based on their trade connections across the Syrian Desert with the Persian Gulf. Trade continued to flourish from the 6th to the 12th centuries, the Arab irruption causing but little interference. Then the Mongol avalanche burst into the Euphrates Valley and Europe lost her hold on Asia, for the land route was severed. On the heels of the Mongols came the Turk, who laid the foundations of the Ottoman Empire on the bridge between Europe, Asia and Africa, completely strangling all Indo-European intercourse. The establishment of the British Levant or Turkey Company in the 16th century gave the first impulse to the revival of the old Euphrates route until, in 1750, the Indo-Syrian caravan tracks came again into a brief period of comparative prosperity. But for the discovery of an unbroken waterway to India and the cutting of the Suez Canal, this route would have remained the highway of the East. Even in the early part of the 19th century, despite the preference for sea-borne trade, the prospects of a revival of the old land-route were encouraging. The proposed Euphrates Navigation Company and Railway were outward signs of a great need which Great Britain was slow to recognize, but which Germany eventually took up and attempted to realize in her road to the East. It is not improbable that future historians, delving in the diplomatic records of the past 25 years, will assign a prominent place among the «causes» of the Great War to the silent struggle for the command of the Mediterranean and the bridge between East and West. From Alexandretta to Aleppo the road is now accessible to wheeled traffic. From this point the pilgrims' route to Mecca and Medina is superseded by the railroad following the Orontes Valley by Hamah and Homs to Damascus, running thence through the Haurân southward to Arabia. Geographically, the Syrian railways form a sort of southern prong of the Bagdad Railway. In Syria railway enterprise began with a roundabout line of 54 miles, running from Jaffa to Jerusalem, opened in 1892. Since then great progress has been made, and altogether about 1,400 miles were in operation in 1914, with electric street cars in Damascus and Beirut. Since the end of 1906, when the section Aleppo to Hamah was opened, a French line has united the former town with Rayak on the line from Beirut to Damascus, with a total length of about 206 miles and a big bridge over the Orontes at Hamah. The same company owned a line from Homs to Tripoli, which was taken up to use the material elsewhere. North of Rayak the lines have the normal or «continental» gauge; all those to the south of this point are narrow guage. Here also is the junction of the French system, a line of about 155 miles, connecting Beirut with Damascus and Mezeril. Starting from Beirut Harbor, the railway climbs up the Lebanon (by cogwheel) for about 5,000 feet to a point just above Ain Sofar, winding thence down to the valley of the Bekaa, in which Rayak junction lies. From there the line runs southeastward across the plain and crosses the Anti-Lebanon to Damascus, to the south of which city the line (which was taken up during the war) ran almost parallel to the west of the Hedjaz Railway. The Hedjaz line was built by the Turks with the assistance of foreign engineers, mainly for the use of pilgrims, and was opened for traffic as far as Medina (820 miles) in 1908. Starting from Damascus, it was never completed to Mecca or prolonged to the Red Sea coast as proposed. It has a branch (22 miles) connecting Bosra with Deraia, as well as a line to Haifa, northwest of Nazareth, and a 25-mile feeder from Amman to Es-Salt. From Beirut a steam tramway runs along the coast 10 miles north to Yunie.

History.— From Egyptian records in stone and papyrus it seems that, at the earliest times known to us, Syria, or at any rate Palestine, was at times a dependency of Egypt. As regards commerce, manufactures and agriculture the country had reached a considerable degree of civilization. A record of the days of Rameses II (1300–1280 B.C.) mentions 38 fortified places in Palestine and 18 more north of Tyre. At an early period Syria became part of the Assyrian Empire, and afterwards passed to the Persians under Cyrus, and the Greeks under Alexander, who conquered the country after the battle of Issus in 333 B.C. Ten years later Ptolemy took possession of Syria and Palestine, and in 312 B.C. began the era of the Seleucides, when Antioch was founded. The Seleucide dominion lasted 248 years, when the conquering Romans made Syria a Roman province in 64 B.C. At this period the Aramaic language was chiefly spoken throughout Syria, although the Greek language and culture were gradually being introduced. Under the Greek and the later Roman supremacy there sprang up, even in remote parts of the country, numerous buildings of great splendor. About the beginning of our era Palmyra was particularly noted for the magnificence of its architecture. The whole of Christian Syria, including Palestine, was wrested from the Eastern Roman Empire by the Persians in A.D. 611–614. Nomadic tribes of Arabs had from time immemorial ranged over the Syrian plain as far as Mesopotamia, and certain Arab tribes from the Yemen were settled in Syria, particularly in the Haurân. For centuries before the rise of Islam the Arabs were everywhere a disturbing element to the Byzantine Empire. The new religion promulgated by Mohammed produced extraordinary results. As by magic, long-standing intertribal feuds among the Arabs disappeared — they became a united nation galvanized by religious enthusiasm. Shortly after the death of the Prophet the Arabs defeated the Byzantines, and Syria fell into their hands (636). It was governed by caliphs till 883, and then passed under various masters till it was conquered by the Seljuk Turks, who gradually obtained possession of the whole country (1070–85). The first Crusade began in 1096; Antioch fell to the Crusaders in 1098. By 1118 the kingdom of Jerusalem had been established and the Franks had taken Cæsarea, Tripoli and Beirut. The next 140 years included the romantic period of Richard Cœur de Lion and Saladin, the latter becoming master of the whole of Syria except the Frankish possessions (1183). North and central Syria were conquered by the Mongols in 1259–60; in 1291 the Mamelukes ended the Frank rule in Palestine and later united Syria with Egypt. After this period the history of Syria presents few points of interest; internal strife continued between the Mamelukes, Circassian sultans and Mongolian governors. In 1400 came the Mongol invasion of Tamerlane, when great numbers of the inhabitants were massacred.

War broke out in 1516 between the Ottoman Turks and the Mamelukes; the latter were defeated by Sultan Selim, and in the following year the whole of Syria was incorporated in the Turkish or Ottoman Empire — a connection destined to be severed 400 years later by the Great War. The more important events in the modern history of Syria are its conquest by Mehemet Ali of Egypt in 1833, and its subsequent restoration to Turkey in 1840 by the intervention of the great European powers; and the disturbances that broke out in the Lebanon district in 1860 between the Maronites and the Druses. A Maronite monk was found murdered, and suspicion fell upon the Druses. The latter made a general attack on the Maronite villages near Beirut and a large town under Mount Hermon. With a promise of protection the Turkish commander ordered the Maronites to lay down their arms. On this being done, they were abandoned to their enemies, who thereupon swarmed into their villages and massacred all men, women and children. So far from rendering the promised protection, Turkish troops were said to have assisted in the butchery. France and Great Britain intervened; a French expedition was dispatched to the scene. Its active services, however, were not required. As a result of that intervention the Lebanon district was created an independent sanjak, the governor of which was required to profess the Christian religion.

During the European War in June 1917 Syria was invaded by a British force under General Allenby who captured Beersheba 31 Oct., Geza 7 Nov., and Jaffa 17 Nov. The victorious troops entered Jerusalem 9 Dec., and Palestine, separated from Syria, was created an independent sanjak under British administration.

See ANTIOCH; BAALBEK; BASHAN; BEIRUT; CRUSADES; DAMASCUS; DEAD SEA; DRUSES; GILEAD; HITTITES; JAFFA; JORDAN; LEBANON, MOUNTAINS OF; MARONITES; MOAB; PALESTINE; PALMYRA; PERSIA, *History;* PETRA; SAMARIA; SEMITES; SEMITIC LANGUAGES; SYRIAC LANGUAGE; TURKEY; TURKOMANS; TYRE; WAR, EUROPEAN — TURKISH CAMPAIGNS.

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HENRI F. KLEIN,
Editorial Staff of The Americana.

SYRIAC LANGUAGE AND LITERATURE, one of the members of the Semitic family of languages. It is a variation or dialect of the *Aramaic* tongue, which covered the districts of Mesopotamia, northern Syria, Damascus and eastern Palestine southward to Arabia Petræa. The language of Syria, especially in its earlier form, differs very little from Chaldee or eastern Aramaic. The Latin equivalent of the name which is *Syriacus* and its Greek equivalent mean of or pertaining to Syria or its language.

Language.— When Syriac first appeared within the view of history it must have been undoubtedly quite an ancient tongue, since its grammatical forms had assumed great definiteness, though it was subject to constant linguistic influence from the powerful and highly organized peoples by which it was surrounded. In later days it continued to be affected by Greek and still later by Arabic, the latter of which contributed to it many words. There was undoubtedly a very considerable body of pre-Christian Syriac literature; but this seems to have disappeared before the iconoclastic and missionary zeal of the Christian priests, though some of it may still be recorded from the ruins of very ancient Syraic cities. Syriac differs very considerably from Hebrew, more especially in its vocal system which is much more condensed than that of either Hebrew or Arabian. In the Aramaic the prefixed definite article does not exist; it is replaced by the ending "a" emphatic, but no longer definite in the sense that the prefixed article is definite. Both Hebrew and Syriac have 22 letters and these are identical in use and form, the dialectic difference of the two tongues being taken into consideration and allowed for. The Syriac tongue possesses 10 vowel sounds (ā a ē e ī i ō o ū u) which were used during the living period of the language, rudicaled in the same manner as in the Semitic tongues. Later on, when it was rapidly becoming a dead speech, two distinctly different methods of representing these vowels came into use. The West Syrians borrowed their's from the Greek alphabet, applying them in a somewhat indefinite manner; while the East Syrians made use of a series of dots by which they secured a much more effective vowel designation. The close relationship of Syriac to Hebrew and Arabic is evidenced by the fact that words having the same root in these three tongues have for the most part the same fundamental vowel sounds, with occasional interchange of letters and some slight and regular modifications indicative of the existing dialectic differences. In Hebrew the accent has a much greater tendency to lengthen the vowel than it has in Syriac, and the latter has a more primitive vowel system than the former. The pronominal suffixes to be found in all the members of the Semitic group of languages effect fewer modifications or changes of the vowels in Syriac than in Hebrew and some of the other members of the group. Syriac possesses no neuter gender, has only two numbers, singular and plural, and had early attained to much more flexibility of construction than Hebrew; and this flexibility the Christian writers steadily increased. The Syriac verb is more regular than the Hebrew form, but it is noticeable for the lack of the original passive forms which have been replaced by distinct grammatical inventions. Syriac has also contributed to its own flexibility by the invention of true tenses with the use of an auxiliary, thus attaining a decided superiority over Hebrew. The use of conjunctions and prepositions shows that Syriac was working steadily in the direction of an analytical construction. Its choice as the tongue in which so much early Christian literature was written was fortunate, since it gave very much greater facility to the expression of thought and the presentation of ideas of so many kinds which has already begun to knock incessantly at the door of a new world of religious and philosophical imagination and reason.

Literature.— The Syriac language is of great importance as the medium of literary expression of so much of the activities of the early Christians and because of the numerous versions of the Bible or parts thereof written in it. The Syriac writers showed all the literary activity of their ancestors and of the Semitic races by which they were surrounded. There is no doubt but that this activity was the legitimate result of long years of literary practice during their pre-Christian life; but unfortunately this early pagan literature has disappeared. But there is plenty belonging to the Christian period still in existence. This covers every avenue of the activities of a people, philosophy, law, science, legend, story, religion, biblical lore, poetry, church government, canonical law, liturgy, biography, historical, romance and theology in all its many forms. Like the Hebrew, Christian Syriac literature shows the ever-present, ever over-brooding spirit of the religious thought which had early in the Christian era obtained such a hold upon the imagination and the affection of the Syrians. The use of Syriac in literature was spread pretty well over the centres of population of the area covered by the language itself as indicated previously in this article. Almost every Syriac city at some time in its career became more or less active in a literary way previous to the Arabic conquest of Syria (636–37) and the body of literature thus produced was large and varied within a certain field limited only by the activities of the people themselves physically and mentally. In fact the Syriac literature is very largely a chronicle of these racial activities. Hence it is not great in a poetical sense. The style and manner of expressing thought is frequently excellent; but Syriac imagery and imagination never rise to the sublime heights of the Hebrew writers. Syriac literature is at its best when it is dealing with all the phases of the Christian religion, history, biography, devotional works and the lives of the saints. Edessa seems to have been the earliest seat of the Christian-Syriac literature which spread rapidly to other parts of the country. This literary activity began probably in the 2d century though legend claims that it had begun in the time of the Apostles. It is in fact quite probable that the translation into Syriac of the Old Testament was made in the 1st century by Syriac Jews; and in the 2d century a compilation of the first four gospels is reported to have been made by Tartian (q.v.) about 180. Many compilations and translations were made from the Old and the New Testaments during the following five centuries. Among the early Syriac writers is Bardesanes, the Gnostic (d. 222). Historian, philosopher and poet, he is reported to have written 150 hymns and to have been an authority on astronomy. Most of these hymns have been lost; but some of them have been preserved in the Hymns of the Soul, in the 'Acts of Thomas.' His 'Dialogue on Destiny.' which is still extant, gives a good idea of his imagination and his clearness of thought. To the following century belong Aphrates the author of homilies popular in his day and for years afterward; Ephraem (d. 337), the most famous commentator, poet and writer of exegetical discourses; and Aba, Balæ, Zenobius and other disciples of the latter who filled much the same field as he. The following century was one of great activity in the Christian Church for it witnessed the separation of the Mesopotamian Christian Church from that of Rome and the division of the former into two sects, the Monophysites (q.v.) and the Nestorians. This led to great literary activity throughout Syria within the body of the Christian society so that the 4th century marks the beginning of the great Syriac literary period which continued active until the Arabian conquest. One of the most noted writers of the 5th century was Isaac of Antioch (q.v.), abbot of a convent. He wrote many hymns and poems and 191 metrical homilies have been credited to him. He denounced the current abuses and luxury of his times much in the mood of the Hebrew prophets of an earlier age in a forceful manner and in a style rich in imagery and marked with imagination. A hundred or more of his poems still exist. Another writer of force belonging to this period was Narses of Maalletha. To the same century belong Ibas, bishop of Edessa, who was deposed from office on account of his Nestorian writings; Dadhisho, commentator; Narsai, "Harp of the Holy Spirit," poet and theological writer, many of whose poems survive; Jacob of Serugh, poet, and Philoxenus of Mabbogh, an excellent prose writer. Among the Syriac writers of the 16th century are John of Tella; John bar Aphtonya, commentator, poet, hymn writer and biographer; Sergius of Rasain, scholar, translator and grammarian; John of Ephesus, noted church historian; Moses of Aggel, translator and writer; Marutha of Seleucia, commentator, sermon, hymn and epistle writer of note; Bodh, logician and translator of Persian tales, and Hannana of Hedhaiyabh, commentator, controversialist and general writer of great activity. Among the historical works of interest written in Syriac are 'Chronicle of Edessa,' 'Chronicle of Dionysius of Tell Mahre' and the semi-religious works of Zacharias of Metylene. The whole body of translations made into Syriac was very large and embraced works from most of the great literatures of the day. This translation continued on into the period of Arabic domination; but Syriac after the middle of the 7th century began to be a dead language. After this period it became the vehicle of the Church and of scholars much as Latin was regarded in Europe. Therefore, the works written in Syriac during the period of Arabian domination are for the most part of a learned nature and the literature tends to run largely to matters ecclesiastical, historical, philosophical and scientific. Among the most noted of the classical Syriac writers are Thabit ben Korrah (9th century); Theodor bar Choni (10th century); Dionysius bar Salibi (12th century), who wrote the 'History of the Crusades'; Michael of Melitene (12th century), 'History of the World'; Abulfar of Gregory (13th century), commentator, grammarian and historian, and Abhdisho (14th century), critic, historical writer and author of a careful work on Syriac literature.

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JOHN HUBERT CORNYN,
Birmingham Southern College.

SYRIAC VERSIONS OF THE BIBLE, entire or in part, are numerous. The most important is the Peshitto (q.v.) or "plain" version of the Old Testament, made probably in the 2d century, and in great part from the Hebrew text, while some of the books are rendered from the Septuagint; originally the Peshitta Old Testament contained only the books of the Hebrew canon; the deutero-canonical books as found in the Septuagint were added later. The New Testament books in the Peshitta Version are the four Gospels, Acts, Epistles of James, 1 Peter, 1 John and 14 Pauline epistles; the early Syrian Church did not receive the other apostolic epistles nor the Apocalypse. In the 2d century Tatian compiled a *Diatessaron* or harmonized compilation of the four Gospels, the greater part of which is extant; for a time the Diatessaron displaced the four Gospels in the Syrian Church. The Monophysites in the 4th century, dissatisfied with the Peshitta, made a complete new version from the Greek texts of the Septuagint and the New Testament. Another translation of the Septuagint was made in the 7th century by Paul, bishop of Constantia; copies of this are extant in the British Museum and in the Ambrosian Library at Milan. Another version of the whole Bible is that used by the Malkites (or Melchites) in Palestine; it is written in an Aramaic dialect more akin to the language of the Jewish Targums than to the Syriac of the Peshitta. See BIBLE.

SYRIAN CHURCHES, those churches in Syria, Mesopotamia and adjoining countries which use a Syriac liturgy; but with them is usually classed the Melchite Church, whose liturgy is Greek. The principal Syrian churches are: (1) That of the Jacobites or Monophysites; they are supposed to number 45,000 families in Syria, Mesopotamia and Chaldæa; they are presided over by two patriarchs. (2) The Syrian Catholic Church, a secession from the preceding in the year 1546; it is constantly gaining accessions from the Jacobites. (3) The Nestorian Church in Kurdistan, Chaldæa and Mesopotamia; its adherents are estimated at 150,000 and are presided over by two patriarchs. (4) The Chaldæan Church in communion with the See of Rome is a secession from the Nestorian Church, and is constantly gaining strength by new accessions from that body. (5) The Maronite Church, with its principal seat in the Libanus, has been in communion with the See of Rome since the 13th century; it is the most flourishing Christian community in Syria. (6) The Melchite Church, in communion with the Orthodox Greek Church. (7) Finally, the United Melchite, or Melchite Catholic Church, in communion with the Church of Rome.

SYRIAN PROTESTANT COLLEGE, an undenominational institution of higher learning at Beirut, Syria, opened in 1866, and the largest American educational institution outside the United States. It was chartered by New York State in 1863 and is controlled by a board of 12 trustees in New York, the faculty conducting the local government. It was the outgrowth of a mission, and is now an independent organization. There are seven departments, preparatory, collegiate, commerce, medicine, pharmacy, training school for nurses and Biblical archæology. It has 18 stone buildings, a 40-acre campus, nine well-equipped laboratories, an anatomical observatory, a hall of science, and hospitals for women and children and for eye diseases. The library contains about 15,000 volumes. There are about 900 students and 70 instructors. The Syrians predominate among the students, but there is a wide representation of nationalities, usually not less than 12. Instruction is in English.

SYRINGA, any of several shrubs. Popularly this name has been applied to the mock orange (genus *Philadelphus*) which has long been cultivated in gardens for its handsome flowers; generically, however, it is the name of the lilac. These two genera belong to different families, the *Saxifragaceæ* and the *Oleaceæ,* respectively. This confusion is a legacy from the old herbalists who united jasmine, mock orange and lilac under the one genus *Syringa,* a feat which also accounts for the use of the name jasmine for *Philadelphus,* among the Germans. Jasmine belongs with lilac in the family *Oleaceæ.* The French, on the other hand, adopt *Seringa* as the popular name for *Philadelphus.* See JASMINE; LILAC; PHILADELPHUS.

SYRINX, si'rinks, in ancient mythology, a nymph beloved by Pan, and who turned into reeds when flying from him. The god is said to have constructed his pipes from those reeds. See MUSICAL INSTRUMENTS.

SYRPHUS-FLY, a fly of the family *Syrphidæ,* smooth or hairy insects, often seen hovering almost without motion over flowers, some of them looking like bees. The species are numerous and the larvæ diverse in habits. Most of the latter feed on the roots or bulbs of plants, or live in decaying wood, mud or sewers, or in the water, or as parasites in the nests of wasps and bumble bees, or crawling over plants in quest of aphides; hence they are sometimes called aphis-lions. The family is very numerous.

SYRTIS, sėr'tĭs, two gulfs of the Mediterranean Sea, on the coast of Africa; the Lesser Syrte, or Gulf of Gabes, is on the east coast of Tunis, between the islands of Dschebado and Kerkenah. The Greater Syrte, or Gulf of Sydra, southeast from the latter, between Tripoli and the plateau of Barka. They form together the most southerly part of the Mediterranean. The navigation of the Syrtes was anciently considered very dangerous, their shores being full of quicksands and their waters impeded by sandbanks, shallows and sunken rocks. The only harbor is Bengasi.

SYRUP, a saturated solution of sugar in water, either simple, flavored or medicated. In preparing syrups the best refined sugar should be used, and either distilled water or filtered rain water; they will thus be less liable to spontaneous decomposition, and will be transparent without undergoing the process of clarification. When vegetable infusions or solutions enter into the composition they should be made perfectly transparent by filtration or clarification before being added to the sugar. The proper quantity of sugar for syrups is about two pounds for every pint of water. It is of great importance to employ as little heat as possible, as a solution of sugar, even when kept at the temperature of boiling water, undergoes slow decomposition. Syrups should be kept in a moderately cool though not a cold place. See SUGAR GROWING AND SUGAR MAKING.

SYRUS, sī'rŭs, **Publius,** Roman author who flourished about 43 B.C. After Laberius he reigned supreme on the stage, and his mimes were full of shrewd epigrammatic wit. About 200 apothegms are still extant, under the title 'Witticisms of Publius Syrus.'

SYSTEM, the term applied to the rocks of a given period; thus we say that the Cambrian system of rocks was laid down during the Cambrian period, the Tertiary system during the Tertiary period, etc.

SYZRAN, sĭz-rāny', Russia, a river-port near the right bank of the Volga, 90 miles southeast of Simbirsk. It has nine churches, a monastery, convent, grammar school, technical school and banks. The manufactures include leather goods and iron-wares. Trade depends upon grain, fish and salt, great quantities of grain being exported. It lies on the Rjashsk-Batonki Railway. Pop. 46,234.

SZABADKA, sŏ'bŏd-kŏ, Hungary, in the county of Bács-Bodrog, 25 miles southwest of Szegedin and 110 miles southeast of Budapest. The fashionable summer resort of Lake Palics lies within its confines. Its chief points of interest are the schools, hospitals, almshouse and music school. Agriculture is the chief occupation. It has considerable trade in fowls, fruit, cattle, horses, hides, wool, corn and tobacco. Linens and shoes are manufactured. Pop. 94,600.

SZECHUAN, sā-choo-ăn', China, the largest province of the republic, in the west, with Tibet on the northwest and Yun-nan on the southwest; area, 218,480 square miles. It is traversed and watered by the Yang-tse-Kiang and its affluents, is hilly throughout, mountainous in the west and rich in natural products, including coal, iron and other minerals. Opium, silk, salt, sugar, medicines, tobacco, hides, musk, rhubarb and white wax (produced by an insect) are exported to the annual value of $25,000,000; and European cottons and woolens are imported to the value of $15,000,000 annually. The capital is Cheng-tu, the chief commercial town Shung-king, which was opened to foreign trade in the end of 1889. Ichang was thrown open in 1877. Pop. of province 54,500,000. (See CHINA). Consult Baber, 'Travels and Researches in Western China' (London 1882); Bishop, 'The Yang-tse Valley and Beyond' (New York 1901); Hosie, 'Three Years in Western China' (ib. 1890).

SZE-MA KWANG, sĕ'mä' kwang', Chinese statesman and author: b. 1009; d. 1086. He is renowned as the author of 'The Comprehensive Mirror of History,' in 294 books, the labor of 19 years. It covers a period from the beginning of the 5th century B.C. to A.D. 960. Sze-ma is also the author of 'Ki-ku-lu' or 'Investigations into Antiquity,' which brings her history down to 1066 A.D. He also wrote a dictionary and numerous essays are ascribed to him. Consult Giles, H. A., 'History of Chinese Literature' (New York 1901), and Rémusat, 'Nouveaux mélanges asiatiques' (2 vols., Paris 1829).

SZE-MA TS'IEN, sĕ'mä' chĕn', Chinese author: b. 163 B.C.; d. 89 B.C. Born in Lungmun, Honan, in 110 B.C. he succeeded his father, Sze-ma T'an, as grand recorder and astronomer, and took up the historical work begun by him. It was finished in 91 B.C. and was named 'Shiki,' or 'Historical Records.' It covers the period from 2697 to 104 B.C. He is also noted for reforming the calendar. The chronology settled by him still prevails in China. Consult Giles, H. A., 'History of Chinese Literature' (New York 1901), and Hirth, F., 'Ancient History of China' (ib. 1911).

SZEBEN, sĕ'bĕn, **NAGY,** nŏd'y, or **HERMANNSTADT,** hĕr'män-stät, Rumania, the capital of a county of the same name in Transylvania. It lies amid beautiful surroundings, among which there are several noted health resorts. The city, which is built partly on a hill, partly on a small river-plain, has handsome, well-paved streets and a large market place. Among the principal buildings are a large Gothic church dating from the 13th to the 16th century and now used by a Lutheran congregation, the city hall, the communal hospital, several large barracks and the palace of Bruckenthal containing a library and collections of art and antiques. There are five institutions for higher education in the city, besides a cadet school, trade schools and a number of minor schools. The principal industries are the manufacture of cloth and blankets, soap, spirits, glue and horn articles, and there are many machine shops, tanneries and two large breweries. The inhabitants are chiefly German Protestants. The formerly important trade with the East has declined. Nagy-Szeben was the capital of Transylvania, and from the 15th to the 17th century was very strongly fortified. It was a city of Hungary until under the Peace Treaty of 1919 with part of Transylvania it was included in Rumanian territory. Pop. about 31,000.

SZEGEDIN, sĕg'ĕd-ēn, Hungary, capital of the county of Csongrad, on the Theiss, 100 miles southeast of Budapest. It lies in a marshy district. It has suffered the ravages of flood and fire, and is now modern in construction and buildings. Its public buildings are prepossessing and include municipal buildings, courts, barracks, theatres, Franciscan monastery with a large and valuable library, museum, etc. There is a fine quay and embankment affording protection against further inundations. The river is spanned by fine bridges for railway and general traffic. The manufactures are soap, paprika, liquor, soda, tobacco, coarse cloth, etc. There is an important trade in wood, corn, wool, cattle, salt and tobacco. Many river boats are built in the yards of Szegedin. In 1526 it was taken by the Turks, who held it until 1686. Pop. 118,300.

SZENTES, sĕn'tĕsh, Hungary, in the county of Csongrad on the left bank of the Theiss, 29 miles northeast of Szegedin. It contains many good buildings, among which is a Protestant church with a fine tower, other churches and a town house. The trade depends upon corn, cattle and wood, in which it has a large trade as also in wine. It has a system of municipal tramways. Pop. 31,590.

SZOLNÓK, sŏl'nŏk, Hungary, a river port and market town in the county of Jázygia, on the right bank of the Theiss. It is the seat of the government courts, a steamboat station and the junction of four railways. Its buildings include a Turkish mosque now used as a chapel, the ruins of a citadel and a Franciscan monastery. It carries on an extensive trade in fruit, grain, cattle, salt and wood — especially the latter. It was the scene of a Hungarian victory over the Austrians on 5 March 1849. Pop. 28,900.

T

T, the 20th letter of the English alphabet and the 16th consonant, is a sharp mute consonant to which *d* answers as a sonant. Its earliest form both in Greek and Latin was but little different from that which it still has; but in some Umbrian and Etrurian inscriptions it is an upright stroke with a small stroke at the top slanting right or left: in early Phœnician and in Hebrew rock inscriptions it has the form + or × or ᚠ. *t* is usually classed as a surd or voiceless dental, but in English pronunciation it might be classed with the cerebrals, being made with the tongue on the hard palate. In French and other languages of Continental Europe the *t* is a true dental, for in pronouncing the letter in those languages the tongue comes in contact with the teeth. The same difference exists between English and those other languages in the pronunciation of *d*. The digraph *th* has two valves in English, namely, the voiceless dental fricative value which it has in *thank, throw,* and the voiced dental fricative value in *that, then*: these two sounds were represented in the Anglo-Saxon alphabet by two different characters, namely þ for *th* in *thank, throw* and ð for *th* in *this, that*: but in Old English manuscripts there was little consistency in the employment of these characters. In some variations of the Irish pronunciation of the digraph *th* in *thin, thorn, through,* etc., is a true aspirate rather than a fricative, the tip of the tongue is pressed against the upper gums and the breath emitted with force; but in correct English pronunciation of this *th* the tongue is brought against the back of the front teeth, with very slight contact, and the breath emitted between tongue and teeth; and there is a similar difference between the Irish and the English pronunciation of *th* in *that, then, this,* etc.; in the Irish pronunciation the tongue is brought into full contact with the teeth. *Ti,* unaccented, before a vowel is usually pronounced as *sh: nation, nashun, motion, moshun; t* before the diphthongal *u* (as in *use*), has the value of *tsh; nature, natshur.*— In the corresponding words of English and the languages akin to it there is interchange of *t* with other letters; examples: Eng. *three,* Ger. *drei,* Goth. *thrais;* Lat. *tres,* Gr. *treis;* Eng. *thatch,* Ger. *Dach,* Lat. *tectum,* Gr. *tegos;* Eng. *brother,* Ger. *Bruder,* Goth. *brothar,* Lat. *frater;* Eng. *dew,* Ger. *Thau;* Eng. *thank,* Ger. *Dank.* Very usually *t* in an English word is represented by *z* in the kindred German word: Eng. *two,* Ger. *zwei;* Eng. *toll;* Ger. *Zoll.*

TNA, is an explosive substance having the formula $C_6H(NO_2)_4NH_2$ which is derived from aniline and has the scientific name of tetranitroaniline. Flürscheim, who, in 1910, proposed to use it as a commercial explosive as it was more powerful than any substance then in use, manufactured it from commercial dinitrobenzene by treating the latter with a solution of sodium bisulphate and then nitrating the product thus obtained with mixed acids at 70° C. or lower. The TNA separated in yellow crystals which when washed and dried had a specific gravity of 1.867 and, when heated at the rate of 5° C. per minute, a melting point of 216° C. and an explosion point of 260° C. Its rate of detonation is 5,500 meters per second. It is an efficient agent for re-enforcing detonators and as a booster, but its stability is questioned.

TNT or **TRINITROTOLUENE.** See TRINITROTOLUENE.

TNX, an explosive substance having the formula $(CH_3)_2C_6H(NO_2)_3$ and whose scientific name is trinitroxylene. It is produced by nitrating the aromatic hydrocarbon known as xylene with mixed acids and fuming nitric acid. Several different compounds having the same percentage and radical composition may be formed but the one produced in largest amount and the one most sought is the trinitrometaxylene. This when pure crystallizes from alcohol in milk-white lamellæ which when slowly heated melt at 176°–177° C. TNX is used either alone or in admixture with ammonium nitrate, as a bursting charge for high explosive shells. It has also been used as a component of blasting explosives such as monachite.

T-RAIL. See RAILS AND STRUCTURAL SHAPES, MANUFACTURE OF.

T-SQUARE, a ruler used by draftsmen, made similar to the common L-shaped square, but of wood, and in the form of a T. It is often graduated in the edges and is convenient for ruling lines at right angles to a base. Sometimes the long arm is made adjustable, so that it may also be used for drawing angles.

TA-KU, tä'koo', China, a small, fortified town situated near the head of the Gulf of Pe-chi-li, southeast of Tien-tsing, and about 80 miles southeast of Peking. It is important as guarding the entrance to the Yung-ting River. It has been the scene of several engagements and was captured by the Allies in 1900, and after the war remained garrisoned by German troops.

TA-LIEN-WAN, tä'lĕn'wän', Manchuria, a bay on the east side of the extremity of the Liao-tung Peninsula, about 40 miles northeast of Port Arthur. The British fleet occupied it in 1860. It is within the territory leased to Russia in 1898. At its head is the northern port of Dalny (q.v.) which was opened to foreign trade in 1901. The construction of a Russian naval station was well advanced when the Russo-Japanese War broke out in 1904 and the bay became the scene of war operations. The adjoining territory passed to Japan in 1905.

TAAFFE, tä'fĕ, **Eduard Francis Joseph von,** Austrian statesman: b. Prague, 24 Feb. 1833; d. Ellischau, 29 Nov. 1895. He was of Irish descent and a Baron of Ballymote as well as Viscount of Austria; was educated at the University of Vienna and entered the civil service. Promotion followed rapidly and in 1867 he became Minister of the Interior. In the following year he also served as acting Minister-President. He had entered politics as a German liberal, but manifested a growing tendency toward Federalism, which he regarded as the only means of reconciling warring factions. In 1870 he joined with two of his colleagues in urging upon the emperor a policy in the direction of Federalism with autonomy, but being defeated in this endeavor, he resigned. In 1871 he became governor of Tyrol and Vorarlberg. In 1879 he was again made Minister of the Interior, formed a new Cabinet and remained at its head until 1893. Devotion to the cause of the emperor was Taaffe's strongest trait, and as this involved the consolidation of the antipathetic nationalities of Austria, he bent every effort in that direction. He worked not through one party, but with any party which by opportune measures could be brought to support his policy, and he relied mainly upon private efforts, for in public he was an inferior speaker. In 1893 he was defeated in his purpose to extend the franchise and his retirement from public life directly followed.

TAAL, tä-äl', Philippines, pueblo, province of Batangas, Luzon, on Balayan Bay at the mouth of the Pansipit River, 13 miles northwest of Batangas, and about 50 miles south of Manila. It is named after an older town on Lake Taal that was destroyed in the volcanic disturbances of 1754. The people are mostly Tagalogs. It is connected with Batangas and other towns by highway, has a well-sheltered anchorage and carries on an important coastwise trade. Agriculture, stock-raising and fishing are also important industries of which Taal is the centre, and sulphur deposits are found in the vicinity. The town is well built on a terraced hill, is an important military station and one of the largest municipalities in the province. It has good schools. Pop. about 36,000.

TAAL, Philippines, a lake. See BOMBON.

TAAL, Philippines, a volcano on Bombon Island in Lake Bombon or Taal, province of Batangas, Luzon, about 40 miles south of Manila. The island from which it rises is 14 miles in circumference; its greatest height is to the southwest, 1,067 feet above the level of the lake; from this point it descends and then rises to a height of 780 feet to the north. The crater is oval and the walls steep; at the base are two steaming lagunas. It supplies large quantities of sulphur. The last eruption recorded took place in 1911; eruptions also occurred in 1709, 1715, 1716, 1731, 1747, 1754, 1808, 1873 and 1911.

TABACO, tä-bä'kō, pueblo, province of Albay, Luzon, on Tabaco Bay, east coast, 15 miles north of Albay, the provincial capital. It has the deepest and best-sheltered harbor in the province and carries on a large trade with Manila, being third port in Albay in the importance of its shipping. Pop. about 25,000.

TABARD, in the times of the Tudors, a tunic-like garment, worn over the armor, covering the body before and behind and reaching below the loins, but open at the side from the shoulders downward; it had wide sleeves or flaps reaching to the elbow and was generally embroidered with the arms of the wearer or if worn by a herald, with those of his lord or sovereign.

TABARI, tä-bä'rē, **Abu Jafar Mohammed Ibn Djerir,** Mohammedan theologian and historian: b. Amul, Taberistan, 839; d. Bagdad, 923. During the first half of his life he widened the area of his learning and experience by traveling from one centre to another of Moslem religion and speculation between eastern Persia and Egypt, devoting himself to the perusal of the Koran and the acquisition of all the lore which jurisprudence, tradition, history and philology had contributed to the elucidation of the Mohammedan scriptures. In about 881 he settled at Bagdad and employed the fruits of his investigation as a teacher and writer in Arabic. His principal works are the ‹Tefsir› or ‹Exegesis,› which contains a complete collection of the existing and independent commentaries of all interpreters of the Koran, with large additions, original and compiled, from abstruse sources. It filled 25 large manuscript volumes and was published in 35 numbers of the *Zeitschrift der Deutschen Morgenländischen Gesellschaft* (1881). His other work is somewhat less important, being a history of the world (‹Annals›) from creation to 914 A.D.

TABASCO, tä-bäs'kō, Mexico, a state situated at the head of the Gulf of Campeachy and bounded by the states of Vera Cruz, Chiapas and Campeche. It is one of the smallest states of the Confederation, its area being 10,072 square miles. The surface consists almost entirely of a great flat, sloping gradually to the sea, but in many parts so low that it is subject to inundations. The streams, though numerous, are short and shallow and are generally obstructed at their mouths by sandbars. The Tabasca, or Gsijalva, River, however, is navigable for 90 miles and the Usmacinta for 175 miles. The climate is excessively hot, particularly along the coast, and in the marshy districts very unhealthful. A large portion of the state is still covered with primæval forests. The principal cultivated crops are cacao, coffee, dye-woods, vanilla, indigo, tobacco and sugar. The inhabitants are chiefly Indians. The capital is San Juan Bautista. Pop. of the state about 190,000.

TABASHEER, or **TABASHIR,** a remarkable substance occasionally found in the hollow joints of certain species of bamboo and other large grasses. It is ordinarily sought for by splitting open those bamboo stems which give a rattling sound when shaken. It is especially apt to be found in the *Bambusa arundinacea* of Indian and other related species of Japan, China, Java and the Andes Mountains. During the rapid growth of the bamboo shoots, their solid joints become hollow and are partially filled with water containing silica in solution. The development of the foliage leads to active transpiration; the water absorbed from the soil quickly disappears and tabasheer is the residue. It is at first jelly-like, but gradually solidifies into small milky-white masses. Physically and chemically these are practically identical with the hydrophane variety of the mineral opal. It is an open question whether tabasheer should be registered as belonging to the mineral or the vegetable kingdom. It is essentially a hydrous silica, the lime and potash which are often present being doubtless simply impurities. Its optical properties are most remarkable. According to Brewster, it has a lower index of refraction than any other solid or liquid, its refractive power being not only lower than water, but so much lower as to be almost intermediate between water and air. The material is isotropic, opalescent and remarkably phosphorescent. It becomes transparent when saturated with water and is remarkably porous. It probably possesses greater absorptive power than any other mineral, Brewster claiming that the pores occupy two and one-half times as much space as the silica itself, notwithstanding the fact that they are invisible even under very high powers of the microscope. From time immemorial it has been highly esteemed in the Orient for its supposed medicinal properties. A knowledge of the substance was introduced into Europe by the Arabian physicians and its name is of Arabic origin. Much so-called tabasheer in Turkey and Asia Minor is artificial. Consult *Nature* (Vol. XXXV, p. 488, 1887).

TABB, John Banister, American poet: b. Amelia County, Va., 22 March 1845; d. 1909. After private study, he was appointed in 1862 captain's clerk to the Confederate blockade-runner *R. E. Lee*, but in 1864 was captured and held prisoner for seven months at Point Lookout, Md. He studied music in Baltimore, taught there, and at Racine College, Michigan, and after courses at Saint Charles College, Ellicott City, Md., and Saint Mary's Seminary, Baltimore, was ordained in 1884 to the priesthood of the Roman Catholic Church. Later he was professor of English at Saint Charles. He privately printed a book of 'Poems' in 1884, and from that time wrote largely for the magazines, gathering his contributions at intervals in various collections. His volumes are 'Poems'; 'Lyrics'; 'An Octave to Mary'; 'Rules of English Grammar'; 'Poems Grave and Gay' (1899) 'Two Lyrics' (1900); 'Later Poems' (1910). Ingenious in matter, compact in form, his favorite length is the quatrain distinguished by an effectively simple diction.

TABBY, a variety of rich watered silk which has undergone the operation of tabbying or being passed through a calender, the rolls of which are made of iron or copper variously figured, which, bearing unequally on the stuff, renders the surface unequal, so as to reflect the rays of light differently, making the representation of waves thereon.

TABBYITE, a variety of asphalt, semi-brittle, semi-waxy, containing a small percentage of ceresin; readily fusible, freely soluble in carbon disulphide; used in making paint, varnish, rubber substitute and pavings. Occurs with other bitumens in Wasatch County, Utah.

TABERNACLE (from Lat. *tabernaculum*, a tent), the tent in which the Ark of the Covenant was deposited during the wanderings of the Israelites in the wilderness and subsequently in Palestine until the erection of a permanent building at Shiloh. When this building was erected does not appear in the Scriptures, but 1 Samuel iii, 3, clearly shows that it existed in the early days of the prophet. The building in which the Ark was is there spoken of as a temple. The sanctity which attached to the Jewish tabernacle led to the use of the word by Christians to designate places considered peculiarly sacred and in the Roman Catholic Church the name is given to the receptacle in which the consecrated elements of the Eucharist are retained. This is a small structure of marble, metal or wood, placed over the high altar and reserved exclusively for the Eucharist. Tabernacle is also in occasional use as a designation of Protestant churches. See ARK; PYX.

TABERNACLES, Feast of, one of the solemn yearly feasts of Israel, directed by the Lord, as set forth in Leviticus, ch. xxiii. It is there commanded that the 15th day of the 7th month shall be the Feast of Tabernacles, to last for seven days. On the first day there should be a holy convocation and no servile work should be done therein. «Seven days ye shall offer an offering made by fire unto the Lord; on the eighth day shall be a holy convocation unto you, and ye shall offer an offering made by fire unto the Lord: it is a solemn assembly, and ye shall do no servile work therein.» The Israelites were further directed to take boughs and branches of trees and willows and to dwell in booths seven days, to remind them of the time when they dwelt in booths in the exodus from Egypt. All orthodox Hebrews observe the Feast of the Tabernacles, which comes in the latter part of September. See JEWS AND JUDAISM.

TABES DORSALIS, an affection of the nervous system akin to locomotor ataxia and paralysis. It is characterized by a lack of power in harmonizing the action of certain muscles, the absence of such co-ordinating power being apparent first in the lower extremities, making the gait straggling and unsteady. There is no true paralysis, but sensitiveness is diminished; the loss of power proceeds and the later stages of the malady are marked by such symptoms as disordered vision, incontinence of urine and exhaustion. The duration of the disease varies from a few months to several years. Its causes are obscure. A peculiar change in the posterior columns of the spinal cord and in the posterior or sensory roots of the spinal nerves accompanies it. Prolonged exposure to cold and damp, drunkenness, sexual excesses, masturbation, etc., have been regarded as causes. Many authorities believe that it is, in many instances, or even exclusively, a remote result of syphilis. It is alleged to be more common in men than in women and subjects between the ages of 30 and 50 are said to be most liable to it. The patient has an unsteady gait and walks like a drunken person, but soon recovers his bearing in some degree. A difficulty in carrying out the intents of the will is experienced and in picking up an object one hand is employed to steady the other. When the eyes are shut the patient walks with extreme difficulty. Tabes dorsalis may be distinguished from disease of the cerebellum by absence of the characteristic pain at the back of the head, and of vomiting. The progress of the disease may be retarded, but the prospect of cure is nearly hopeless. The treatment is limited to improvement of the general health: warm clothing, nutritious food and rest are the chief items. Salvarsan is sometimes injected directly into the spinal column with good results. Consult Osler, William, 'Practice of Medicine' (New York 1912).

TABLAS, tä'bläs, Philippines, the largest and most western island of Romblón province, 15 miles north of the island of Panay; length, north and south, 40 miles; width, 13 miles; area, 320 square miles. The island is mountainous; the highest peak, in the extreme northeast, has an elevation of 2,405 feet; the coasts are mostly abrupt; on the west coast are several good anchorages for small craft; Loog has the best harbor. There are no good roads and few trails; communication between the towns, which are all on the coast, is by sea. The chief industries are agriculture, stock-raising and fishing; but these are almost entirely for domestic purposes. The island is heavily wooded, but lack of communication with larger islands has prevented the development of the forest resources. Pop. about 26.000

TABLE-LAND, or **PLATEAU**, an elevated flat tract of country of considerable area. In ordinary usage the term is applied to such flat areas elevated above 1,000 feet from sea-level. The level character of the plateau may be due to the horizontality of the strata composing it, the surface being formed by a resistant stratum, or it may be due to subaerial or marine denudation of a flexed and folded mountain region, the erosion having proceeded so far as to reduce the region to a nearly level tract or peneplain, which is then elevated bodily. Any portion of the ancient mountain system not worn away will rise as a peak or mountain range above the peneplain surface, and constitute a *monadnock*. A plateau of this type — that is, an elevated peneplain — may be readily recognized by the disagreement of the slope of the strata composing it with the level surface of the peneplain, the two not infrequently making an angle of 90 degrees with each other. When a young plain of deposition with horizontal strata is elevated into a plateau, and the rivers begin to cut their channels down into it, it is in the beginning of its first geographic cycle. If it remains stationary at the altitude to which it was raised, the rivers will eventually incise their channels to such a depth that their bed from ocean to head is almost perfectly graded. Then lateral erosion will widen the valley bottoms, and reduce the portions of the plateau between the river valleys until finally these separating remnants of the plateau have dwindled to such an extent that they appear as ridges or peaks rising from a level plain, which latter is the result of the confluence of all the river valleys cut into the former plateau. This is the beginning of the peneplain stage, and continued erosion will bring the surface nearer to a perfect plain not far above sea-level. If this is reached, the first cycle of geographic development is complete. The second cycle is inaugurated by a re-elevation of the land into a new plateau, when the whole process will be repeated. In like manner a folded mountain region may be worn down to a peneplain, and re-elevated to enter upon the next cycle of erosion. Most plateaus are probably elevated peneplains, either of horizontal strata or of more or less strongly folded and truncated strata. Into these the present drainage has incised itself more or less successfully. Thus the New England region is a peneplain plateau, of inclined strata, whose surface, moderately redissected by streams, slopes gently toward the coast. Southern New York, western Pennsylvania, Ohio and other districts are part of a plateau in which the strata are nearly horizontal and which has been more or less strongly dissected. This extends southward into Tennessee where it is known as the Cumberland plateau. It is probably past its first cycle of erosion, and appears to have been a peneplain.

Among other noteworthy plateaus of North America are the «High Plateaus» of southern Utah, which range in elevations from 7,000 to 9,500 feet above the sea, their elevation being connected with that of the Wasatch Range of mountains. Between the Rocky and Sierra mountains extends a broad plateau from Mexico northward through British America. It averages from 3,000 to 5,000 feet in elevation, and is deeply dissected by the cañons of the Colorado, the Columbia and other rivers. The portion included between the two rivers named is called the Great Basin. It is bounded on the east by the Wasatch Mountains, and on the west by the Sierra Nevada and Cascade ranges, and has a width of nearly 500 miles, with an elevation of 4,000 to 5,000 feet. It has no outside drainage, and hence the streams are short, and the water bodies saline. Great Salt Lake and Mono Lake in California are respectively on the eastern and western side of this plateau, and the surface between is arid and more or less desert. Similar conditions exist in the Mexican extension of this plateau. A higher type of table-land — to which the name intermont plateau has been applied — is found in the great plateau of Tibet between the Himalayas and the Kuen-lun Mountains. Its altitude is about 13,000 feet, while the enclosing mountains rise from 25,000 to 29,000 feet in height. It is 1,200 miles long from east to west, and half as wide. The plateau of Quito is 10,000 feet above sea-level and surrounded by lofty peaks rising 20,000 feet or more. That of Bolivia has an elevation of 12,900 feet with Lake Titicaca at 12,830 feet, and the city of Potosi at 13,330 feet elevation.

The plateau of Spain averages 2,250 feet in elevation, that of Auvergne, in France, about 1,100 feet. Bavaria is a plateau rising 1,660 feet. Persia is another from 2,000 to 4,000 feet above the sea. The Abyssinian plateau in Africa averages 7,000 feet above the sea, while much of the Sahara region is about 1,500 feet above sea-level. The table-land character of all these regions appears only in a general view. Owing to the dissection of the plateaus they appear as a rule anything but level to the traveler unless a comprehensive view from a summit is obtained. Many of the larger plateaus are also traversed by mountain ridges.

TABLE LAWN-TENNIS. See PING-PONG.

TABLE MOUNTAIN, Cape Colony, Africa, a flat-topped mountain with nearly perpendicular sides, situated just south of Cape Town. Its height is 3,540 feet.

TABLE TURNING, in psychical phenomena, the tipping or moving of a table at a séance, usually at gatherings of believers in spiritual manifestations. A number of persons form a circle round a table, on which their outstretched fingers lightly rest. They assume a passive state, usually sitting in a dim light, and sometimes listening to soft music. After a time the table begins to move, and on some occasions to answer questions either by tilting or rapping at appropriate letters as the alphabet is repeated. Faraday was of opinion that a rotary impulse was unconsciously imparted to the table by those who stood around it, and it has been pointed out that pushing may take place without any distinct consciousness on the part of those who push, and that expectant attention is known to produce such a state of the muscles as would occasion this unconscious pushing. The principle involved is the same as in planchette and the ouija board, and has been investigated exhaustively by the Psychical Research Society. Consult Podmore, F., 'Modern Spiritualism' (London 1902). See SPIRITUALISM.

TABLEAUX VIVANTS, tăb'lō vē'vän (French «living pictures»), are representations of scenes from history or fiction by means of persons grouped in the proper manner, placed in appropriate postures, and remaining silent. They are supposed to have been first introduced by Madame de Genlis, instructress of the children of the Duke of Orleans.

TABLES, Lunar. See LUNAR TABLES.

TABLINUM, in Roman antiquity, an apartment in a house in which were deposited the genealogical records and archives, and all documents commemorating the exploits which had been performed by members of the family, or which were connected with the high offices which any of them had filled. It was usually located opposite to the entrance.

TABOO, or TABU, a word of very extended meaning used by South Sea Islanders, to denote something consecrated, sacred, forbidden to be touched, or set aside for particular uses or persons. It is applied both to persons and things, and both to the object prohibited and to the persons against whom the prohibition extends. Thus a consecrated piece of ground is taboo, the act of consecrating it is called taboo, and the persons who are excluded from entering are also said to be tabooed. It is taboo among certain tribes, for any inferior to touch the body of a chief living or dead, or anything belonging to him; to eat in his presence, or anything he has touched; to cross his threshold otherwise than on the hands or knees, or to mention his name. A particular article of food is sometimes tabooed at a certain season in order to preserve it against a season of scarcity, etc. In the case of a serious infringement of the taboo the punishment is death; in less heinous cases a sort of outlawry, the neighbors being permitted to appropriate or destroy the offender's goods.

The word «taboo» has been adopted into English to designate similar customs among races, apart from those from which the term was derived; and has assumed a colloquial sense which is altogether non-religious and negative, though the word was originally used more to designate definite religious ceremonies that were obligatory upon the tribe or upon the individuals composing it. These ceremonies were observed at certain stated times and under certain conditions, generally in connection with important undertakings. In many Indian tribes of America, the warrior who succeeded in killing an enemy was required, on his return to his home, to undergo certain purification ceremonies before he could again resume his former relations with the members of his tribe. Until these ceremonies had been performed, not only were these former relationships tabooed to him, but he was himself tabooed to the tribe; and any one violating the conditions of the taboo became himself tabooed. Always during the period of duration of the taboo, the individual or individuals subject to it are denied the exercise of certain privileges. The taboo may be temporary or permanent; it may be ceremonial, belonging to a fixed and definite period in life, or it may be occasional. Most ancient races had a particular taboo connected with birth, puberty, marriage, death, and even with periods previous to birth and after death; with the assumption of public office and with almost every undertaking in life. Probably most of these customs had their origin in the fear of the superior power of certain deities or evil-disposed spirits and a desire to propitiate them. But in time many of them came to be of a more or less religious and formal nature, and thus many religious observances were formerly taboo in character. Very numerous are the things which have been subject to taboo; but they may be classed under a few more or less definite heads of a general nature. These include objects unclean in their nature, or through mythical, superstitious or religious association; things supposed to belong to, to be possessed by, or to be influenced by spirits or beings feared on account of their mysterious power; strange or unknown objects or customs which it is the part of good sense to propitiate beforehand in case they should prove powerful and ill-disposed. The dread power of priests and rulers was especially feared for it was held little inferior, if any, to that of ghosts, witches, and the supernatural people in general, and superstitious animals.

Opposed to those taboos of fear were those inspired by a desire of personal advantage. Of this nature were the offerings and prayers offered to household gods and to certain deities before undertaking any enterprise of a personal nature. The priest, as the representative of the tribe or the nation, performed the same ceremonies for them and with the same end in view. In connection with these ceremonies there were certain taboos. On opening a cask or bag of wine, the first cupful was tabooed to all but the gods of growth and fertility who made the production of the wine possible. The firstlings of the flock were given to the protector of the herds, the ancient god of hunting; the first fish caught by the fisherman, the first game taken by the hunter, the first ripe fruit and vegetables grown by the husbandman were all, in like manner, tabooed to their possessors. There was not a movement or interest in life without its taboo of a similar nature. Not infrequently the two ruling motives of fear and hope of personal gain are found combined in the same taboo, for a much feared and suspected superior being might, if propitiated, become a valuable ally and helper in time of need.

Taboo associations had much to do with totems and every totem had its taboo. Among many American Indian tribes, a hunter might not kill the animal represented by his totem. Among certain others only a part of such animal was tabooed. The moon being the goddess of fertility, her power was greatest when her full face looked toward the earth. Hence among many races, the planting of grain was tabooed except at the full of the moon. Yet potatoes and bulbous plants could be planted only when she showed the least of her face, for it was feared she might make the part above the ground grow at the expense of that beneath it. Among the forest tribes of the eastern United States and Canada the killing of the ground squirrel was tabooed because he was credited with the discovery of medicines or their introduction to man. Among the Algonquins the white rabbit was tabooed to the hunter because the great culture god Nanabozho frequently assumed the form of a white rabbit. The white dog could not be eaten by the plains Indian because he was reserved as an offering to the great spirit. Among many primitive peoples the names of the dead were tabooed for a certain length of time lest the pronouncing of them might call their spirits back to earth or incite them to unfriendly action. To such a length was this fear of the dead carried that some tribes buried the name with the departed and in its place bestowed another by which the dead was afterward referred to and remembered. Sometimes tabooes were as wide as the tribe or the nation; and many of these ancient tabooes have survived in the shape of national feeling against the use of certain objects.

The custom of making certain places sacred to certain deities arose out of the practice of setting apart such places for the worship of these deities, or through the fact that certain places were believed to be the abode of all powerful beings. This belief tabooed such places to all but the powerful beings who it was claimed had already pre-empted them. (See NATURE WORSHIP; AMERICAN MYTHOLOGY). Consult Bancroft, 'Native Races' (New York); Frazer, J. G., 'The Golden Bough' (London and New York 1907–13); Gennep, 'Tabou et totemisme á Madagascar' (Paris 1904); Waite, Gerland, 'Anthropologie der Natur-Völker'; Smith, W. R., 'Lectures on the Religion of the Semites' (New York 1907); Sumner, W. G., 'Folkways' (Boston 1907); Taylor, 'Te Ika A Mauri, or New Zealand and Its Inhabitants' (London 1870).

JOHN HUBERT CORNYN,
National University of Mexico.

TABOR, Horace Austin Warner, American miner and capitalist; b. Holland, Vt., 30 Nov. 1830; d. Denver, Colo., 10 April 1899. He learned the stonecutter's trade in Massachusetts; removed to Kansas in 1855, and four years later to Colorado, and settled in California Gulch, a place he later named Leadville. In 1878 he with his partners struck a rich deposit of silver in the mine later known as Little Pittsburg. In 1879 he sold his interest in this mine for $1,000,000, with which sum he engaged in speculation and increased his fortune to $9,000,000 in 10 years. He became mayor of Leadville and gave large sums, both to this place and to Denver, for the erection of public buildings. Leadville, accordingly, when hardly more than a mining camp, was given an opera house costing $500,000. In 1878 he was elected lieutenant-governor of Colorado, and from February to March 1885 was United States senator in place of Henry M. Teller, who had entered the Cabinet. From that time his fortunes began to decline and by 1897 his entire accumulations had been swept away. He returned to mining on a small scale, and in 1898 was made postmaster of Denver.

TABOR, Palestine, now called *Jebel et Tûr* or *Jebel Tor*, "the Mountain," a remarkable hill, eight miles east of Nazareth, rising abruptly in the shape of an almost perfect cone from the northeastern arm of the plain of Esdraelon to a height of nearly 1,000 feet, or 1,840 feet above sea-level. It is well-wooded; the dark green of the walnut, the rose bushes, the yellowish-white styrax blossoms, the pistacia and oak trees — all these and many others beautifying the path to the summit, where a view is obtained, embracing Galilee, Samaria, Peræa, and reaching as far northward as the snow-crowned Hermon. The coverts afford a shelter for wolves, wild boars, lynxes and various reptiles. The isolation of this mountain doubtless led to its being made by the earlier ecclesiastics the scene of the Transfiguration. Historical data, however, shows that the summit was occupied as a stronghold from the times of Antiochus Magnus (218 B.C.) until the destruction of Jerusalem under Vespasian. Architectural remains still exist on the summit. Consult Baedeker, 'Palestine and Syria.'

TABOR COLLEGE, located at Tabor, Iowa. It was chartered in 1854 as Tabor Literary Institute, and an academic department opened in 1857; the collegiate department was established and the name changed to Tabor College in 1866. It is non-sectarian in control; but owes its foundation and support largely to the Congregationalists, and is endorsed by the Congregational Conference of Iowa; a committee from this conference examines the work of the college each year. In addition to the regular collegiate courses, there is an academic department with a three years' course, and a conservatory of music. The college work is arranged according to the group system, all groups leading to the degree bachelor of arts. Diplomas are granted to graduates from the academy and the conservatory of music. The college is coeducational.

TABORITES, a group of the followers of John Huss, who was condemned as a heretic by the Council of Constance, and burned at the stake, 6 July 1415, and his ashes strewn on the river Rhine. Others of the faith were known as Hussites. These exasperated followers took cruel revenge on priests and monks of the Church. King Wenceslaus of Bohemia pacified them by granting them religious freedom and the use of some of the churches. After the death of the king in 1419, the Pope issued a command for the conversion or suppression of the Hussites, and the latter took up arms and assembled under the leadership of John Ziska on Mount Tabor. They captured Prague, burned the monasteries and defeated the imperial troops. Their success was continuous for about 15 years until the division between the more radical branch known as Taborites, who acknowledged the Scriptures as the only source of authority, and the Calixtines, who leaned to Roman Catholic principles of faith, became acute. The Calixtines came to an understanding with Rome, and the Taborites, left to fight alone, were signally defeated in 1434. The struggle with the empire terminated, however, in the concession of civil and religious freedom to Bohemia by the Emperor Sigismund in 1436, but civil war raged at intervals in Bohemia until 1485, when King Ladislas confirmed the imperial grant. See HUSS, JOHN.

TABRIZ, tä-brēz', or **TAVRIS,** tä-vrēs', Persia, a city in the extreme northwest, about 50 miles from the Russian border, capital of the province of Azerbaijan, on the left bank of the Aji, 36 miles above its entrance into Lake Urumiah. It is situated at the inner extremity of an amphitheatre, about 4,000 feet above sea-level, with hills on three sides, and an extensive plain on the fourth. It is surrounded with a wall of sun-dried brick, with bastions, and is entered by seven or eight gates. A large portion of the population resides outside the walls, and the plain around is covered with gardens, producing the finest fruits in great abundance, particularly grapes. The citadel is the most conspicuous building in the city. It was originally a mosque, and is 600 years old. It consists of a lofty edifice of brick, and though much damaged by earthquakes, is still a noble structure. Within the walls of the citadel there are a cannon-foundry and barracks. The most interesting building in the town is the fine ruin Kabúd Masjid (Blue Mosque), which is about 300 years old, and is partly covered with arabesqued tiles. A considerable trade is carried on in the import of European goods and sugar, the former consisting mostly of cotton manufactures, principally British, petroleum from Russia, and woolen goods, chiefly from Austria and France; and in the export of raisins and other fruits, leather, carpet, silks, skins, cottons, shawls, tea, etc., principally to Russia and Turkey. The imports and exports in normal years total over $10,000,000. Though still a considerable city, Tabriz has diminished in importance from what it was in ancient times; the descriptions of old travelers, who speak of its splendid cafés and its hundreds of caravansaries and mosques, being no longer applicable; while its ancient population of 550,000 had dwindled to about 165,000 in 1881, although in 1918 estimated at 200,000. The city has been repeatedly devastated by earthquakes, the most destructive being those of the years 858, 1041 and 1721; on the last occasion 80,000 persons are supposed to have perished. During the World War the city was occupied first by the Turks and later by the Russians.

TABULAR STANDARD OF VALUE, a project for giving fixity to the value of money by varying from time to time the amounts of gold to be paid according to the changes in its purchasing power. The practical object which those who advocate the adoption of this standard of value proposed is the attainment of a perfectly stable currency for the payment of rents or other deferred contracts. A tabular standard, therefore, if adopted would be simply an official index number. (See INDEX NUMBER). According to Jevons it is proposed that a considerable number of commodities, say 100, should be chosen with special regard to the independence of their fluctuations one from another, and then the geometrical average of the ratios in which their gold prices have changed would be calculated logarithmically. The system involves the proposition that these average prices should constitute the legal standard for settling contracts expressed in money — thus, if a note was signed in 1915 pledging the payment of $1,000 in gold in 1920, and it appeared that in 1920 that $1,000 would then buy upon the average of all commodities one-fourth less than it would have bought in 1915, the debtor should be compelled to pay $1,333 to the creditor in 1920 in full satisfaction of the debt; since in 1920 the sum of $1,333 will purchase only what $1,000 would purchase in 1915. It is claimed by its advocates that such a standard would add a wholly new degree of stability to social relations, securing the fixed incomes of individuals and public institutions from the depreciation which they have often suffered. Speculation, too, based upon the frequent oscillations of prices, which take place in the present state of commerce, would to a large extent be discouraged. The great obstacle to its adoption is the difficulty of getting economists to agree upon the precise manner of fixing the standard and calculating the averages of the several commodities, and even agreeing upon the inclusion of the latter. The idea of a tabular standard appears to be due to Sir George Evelyn who advocated «a standard of Weights and Measures» before the Royal Society in 1798. Joseph Lowe further elaborated the idea in 1823 in his ‹Present State of England.› Scrope followed Lowe and nearly all economists of the 19th century were interested in the tabular standard. W. S. Jevons brought the matter into prominence in 1865, and further elaborated it in his later works. Consult Palgrave, ‹Dictionary of Political Economy›; Anderson, B. M., ‹The Value of Money› (New York 1917); Price, ‹Money and its Relation to Prices› (London 1896); Walker, ‹Money› (New York 1878).

TABULARIUM, in Roman antiquity, a depository of public records; specifically, a building for the preservation of such records which stood on the slope of the Capitoline Hill in Rome facing the Forum. It was built (78 B.C.) by the consul Quintus Lutatius Catulus. The masonry of many of its great vaults and columns is still intact, although another structure has been erected on the old walls.

TACAMAHAC, the name of various oleoresins allied to elemi, exuded by different species of trees. East Indian tacamahac, yielded by *Calophyllum inophyllum* of Réunion and Madagascar, is a dark-green balsamic resin of specific gravity 1.032, melting at 75° C. A yellow variety is produced by an African tree (*Amyris tacamahac*), and another kind comes from the Brazilian *Icica heptaphylla*. The balsam poplar (*Populus balsamifera*) of the United States yields a similar resin.

TACANÁ, Guatemala, a volcano on the Mexican frontier, which rises to a height of 12,400 feet. It is one of several neighboring volcanic peaks of the Cordilleras, and is second in height to Tajumulco which reaches an elevation of 12,600 feet.

TACCA, the typical genus of the family *Taccaceæ*. It is represented by perennial herbs with tuberous or creeping rootstocks, large radical leaves, and dense umbels of flowers, brown, purple, or greenish in hue. These terminate a naked scape and have an involucre of bracts, the inner being filiform and pendulous, the outer herbaceous or colored. The fruit is a berry, usually three-angled or six-ribbed. *Tacca pinnatifida* is the South Sea arrowroot, or pia-plant, found in Polynesia and southeastern Asia. It is a low plant, with dissected horizontal leaves and an umbel of greenish flowers.

TACHÉ, Alexandre Antonin, Canadian Roman Catholic archbishop: b. Rivière-du-Loup, Quebec, 23 July 1823; d. Winnipeg, Manitoba, 22 June 1894. After graduating from the College of Saint Hyacinth and studying theology at Montreal, he became a member of the Order of the Oblate Fathers. He then started out as a missionary for the Northwest and there began the charitable work among the Indians of the Red River country which made him famous. He was consecrated (1850) bishop of Arath, and (1863) bishop of Saint Boniface. When the bishopric of Saint Boniface became a metropolitan see in 1871 Taché was appointed its first archbishop. In 1870 while bishop of Saint Boniface at the urgent request of the Canadian government, he performed the service of pacifying the Métis of Manitoba, who had rebelled. Among his published works are 'Vingt années de missions dans le nord-ouest de l'Amerique' (1866); 'Esquisse sur le nord-ouest de l'Amerique' (1869), etc.

TACHÉ, Sir Etienne Paschal, Canadian politician: b. Saint Thomas, Quebec, 5 Sept. 1795; d. there, 29 July 1865. He practised medicine until 1841, when he became a member of Parliament; from 1848–49 was commissioner of public works; and from 1856–57 was speaker of the legislative council. He published 'Du developpement de la force physique chez l'homme' (1829); 'Reflexions sur l'organisations des volontaires' (1863).

TACHEOMETRY, tăk-ȩ-ŏm'ē-trĭ, quick measuring, applied in surveying to a method which does away with the practice of measuring distances by a chain or tape-line and ascertaining difference of level by a separate instrument, the relative position, both horizontal and vertical, of points on the earth's surface being determined by one observation. A theodolite, or a specially constructed tacheometer, of which a telescope is an important part, is employed, and along with it a staff similar to a leveling-staff, 12 feet or so in length, and suitably marked. See SURVEYING.

TACHINA-FLIES, flies of the family *Tachinidæ*, a large and important group resembling house flies and noted for their parasitic habits. They are usually of medium or rather large size and gray, more or less striped; the wings clear, the bodies bristly; and have a disposition to fly in the sunshine with a buzzing noise. All are parasitic and are especially fond of laying their eggs upon the backs of caterpillars. For many interesting features in the life of these flies consult Howard, 'The Insect-Book' (New York 1901), and the special papers there cited.

TACHYGRAPHY. See SHORTHAND.

TACITUS, tăs'ĭ-tŭs, **Marcus Claudius,** Roman emperor: b. about 200 A.D.; d. Tyana, Cappadocia, April 276. He was descended from Tacitus, the historian, whose works he deposited in all the public libraries and caused them to be transcribed 10 times a year at the public charge. On the death of Aurelian he was called to be emperor by the Senate, although against his will (275), having gained the confidence of the supreme council by his mildness, rectitude and moderation. During his short reign he prescribed many needed reforms and endeavored to restore the power of the Senate. At the age of 75 he undertook a campaign against the Alani, assuming after his victory the title «Gothicus Maximus.» He was assassinated by his own unbridled soldiers; his brother Florianus Tacitus, who succeeded him, shared a like fate.

TACITUS, Publius Cornelius, in the judgment of many competent critics the greatest Roman historian. Neither the time nor the place of his birth is known, but certain statements in his own works and in the letters of the younger Pliny (the two chief sources of our information about him) make it probable that he was born about 55 A.D. His education, marriage and political career all point to a family of equestrian rank, and his father was not improbably that Cornelius Tacitus who, according to the elder Pliny ('Natural History,' VII, 76), was procurator of Gallia Belgica. He married in 78 the daughter of Gnæus Julius Agricola, the illustrious governor of Britain. He enjoyed the official favor of Vespasian and Titus, and, at least at first, of Domitian, under whom, in the year 88, he presided, as prætor and as a member of the ancient college of the Quindecimviri at the celebration of the secular games. After his prætorship, he was for four years absent from the capital, and was thus prevented from being present at the death of Agricola, which took place in Rome in 93. During these years he was probably acting as prætorian legate in a province, and may have gained at this time some personal knowledge of Germany. In 97 (possibly 98) he was appointed consul to succeed Verginius Rufus, over whom he pronounced an eloquent funeral oration. He was an intimate friend of the younger Pliny, a few years his junior, with whom he was associated, in 100, in the successful prosecution of Marius Priscus, accused of extortion by the province of Africa. According to an inscription discovered in 1890 at Mylasa, in Caria, Tacitus reached, perhaps in the year 112–13, the highest post open to a senator, the pro-consulship of Asia. The date of his death is not known, but, inasmuch as the extension of the empire to the Persian Gulf, which was accomplished by Trajan in 115–16, is mentioned in 'Annales,' Vol. II, 61, and several years were presumably required for the completion of that work, he may have lived into the reign of Hadrian, which began 117 A.D.

His earliest work is the 'Dialogus de Oratoribus,' written probably under Titus, 79–81. The scene of the conversation is laid in the house of the poet Maternus, in the year 74–75, and a charming discussion of the relative merits of poetry and oratory leads up to the main theme, the decline of eloquence in modern times. The treatise abounds in true and striking reflections, and exhibits the same power of subtle analysis that marks the later works. But the style is distinctly Ciceronian, and in its rounded smoothness, so different from the abrupt incisiveness of the 'Histories' and 'Annals,' shows the influence of Quintilian, who was then preaching a return from the style of Seneca to that of Cicero. For this reason the great Justus Lipsius, in 1574, attributed the 'Dialogus' to Quintilian, and since then it has been ascribed to Suetonius, Pliny and others. But the weight of evidence is decidedly in favor of the Tacitean authorship.

During the 15 years of the reign of Domitian, years whose horror finds sombre expression in the opening chapter of the 'Agricola,' Tacitus published nothing. But early in 98 there appeared, in rapid succession, the 'Agricola' and the so-called 'Germania.' The former, the story of the life of his father-in-law, whom he evidently loved and reverenced, is a masterpiece of biographical writing. The style is no longer Ciceronian but Sallustian, rapid, terse and piquant, rising at the close to sustained sublimity. The second monograph is commonly known as the 'Germania,' but its exact title is differently given in the important manuscripts and cannot be determined with certainty. It falls into two parts. The first 27 sections deal with the physical characteristics of Germany and the institutions, beliefs and customs of the inhabitants as a whole; the remaining 19 describe the individual peculiarities of the separate tribes. The treatment is rhetorical and ethical rather than simply scientific, so that the purpose of the essay has often been questioned and the credibility of its statements attacked. But it is regarded as on the whole a trustworthy account of German lands and peoples, though the geography is weak and the description of the tribes in the interior may have been based upon insufficient evidence. The Germans were then the object of much interest (Trajan was in Cologne at the time of his accession) and Tacitus, writing to satisfy this curiosity, pointed out at the same time to his countrymen, the contrast between their own corrupted civilization and the vigorous simplicity of these Northern tribes, and gave a warning of possible danger.

In the introduction to the 'Agricola,' Tacitus announced his intention of composing *memoriam prioris servitutis ac testimonium præsentium bonorum*. The first part of this plan was realized in the years 104–10 by the publication of the 'Historiæ,' consisting originally of 14 books, or possibly only of 12, covering the period from the death of Nero in 68 to that of Domitian in 96. But, instead of adding the reigns of Nerva and Trajan, he then wrote the 'Annales,' in 16, or possibly 18 books, from the death of Augustus in 14 ('*Ab excessu Divi Augusti*' is the actual title of the work) to the point at which the 'Historiæ' begin. Of this remarkable achievement, the continuous history of the empire for 82 years, there is extant about one-half. Of the 'Annales' we have books I–IV with the beginning of V and the greater part of VI, and, with a gap at the beginning and also at the end, books XI–XVI, that is, we have lost almost entirely the years 29–31 of the reign of Tiberius, the whole of the reign of Caligula, the first six years of Claudius, and the last two of Nero. The extant portion of the 'Historiæ' ends in the middle of book V and describes the eventful year 69 and part of 70. The treatment is obviously much more minute in the 'Histories' than in the 'Annals,' and this is due to the fact that Tacitus is here dealing with occurrences which came well within his own lifetime. The loss of the reign of Domitian is especially to be regretted.

Interesting as are the minor works, it is in the 'Histories' and the 'Annals' that the real genius and literary art of Tacitus are revealed. His methods are essentially scientific, though he does not use archives and original sources as much as would a modern historian. But he strives conscientiously to ascertain the facts and to determine the sequence of cause and effect. A thorough aristocrat and lover of the old republic, he yet bows to the inevitableness of the empire and appreciates the enlightened rule of a Trajan. But the reign of Domitian permanently embittered his soul. He was gifted by nature with a marvelous power to trace the hidden springs of thought and action and experience of life bred distrust and made him an expert in the analysis of human weakness and guilt. His portrayal of Tiberius, for instance, though certainly prejudiced and unjust, is extraordinarily subtle and brilliant. The style, which we may see in process of formation in the 'Agricola' and 'Germania,' is characterized by pregnant brevity, leading sometimes to obscurity, by deliberate avoidance of balance in the structure of the sentences and by poetic phraseology. The influence of Virgil is marked. See GERMANIA.

Bibliography.— The standard text is that of Halm (Leipzig 1907). The 'Dialogus' has been admirably edited by Peterson (Oxford 1893) and by Gudeman (Boston 1894); the 'Agricola' (Oxford 1896), and also the 'Germania' by Furneaux (ib. 1894); the 'Historiæ' by Spooner (London 1891); the 'Annales' by Furneaux (2 vols., Oxford 1891, 1896). There is a fine special lexicon by Gerber and Greef (Leipzig 1903). There is an excellent translation of all the works by Church and Brodribb (London 1905); of 'Annales,' I–VI by Ramsay (London 1904); of the 'Histories' by Fyfe (Oxford 1912); of the 'Dialogus,' 'Agricola' and 'Germania' by Fyfe (Oxford 1908) and by Peterson and Hutton (Loeb Classical Series, New York 1914). Consult also Boissier, 'Tacitus and Other Roman Studies' (New York 1906).

NELSON G. MCCREA,
Anthon Professor of the Latin Language and Literature, Columbia University.

TACKLE, among seamen an arrangement of two or more blocks, with suitable ropes, for raising or lowering weights. The combination is usually designed to increase the capacity of the available power. One block is fixed while the others are movable. Tackles are termed luff and watch, single and double Spanish burtons, Bell's purchase, luff upon luff, etc., according to the arrangement of the bearings, pulleys, etc. See BLOCK; PULLEY.

TACKS. See NAILS.

TACLOBAN, tä-klō'bän, Philippines, pueblo, capital of Leyte Island; on the east coast at the southern entrance to the San Juanico Strait, on the northwest extremity of San Pedro Bay. It is the northern terminus of the east coast highway, has an excellent port, with four large wharves. Pop. about 12,000.

TACNA, täk'nä, Chile, (1) a province occupying the northernmost extremity of the country. Area, 8,686 square miles. The main ridge of the Andes runs just within the eastern boundary and a lower range runs along the coast. Pop. about 30,000. (2) Its capital, a city of about 14,000 population, of local importance. The Chileans defeated the Peruvians in a battle here in 1880.

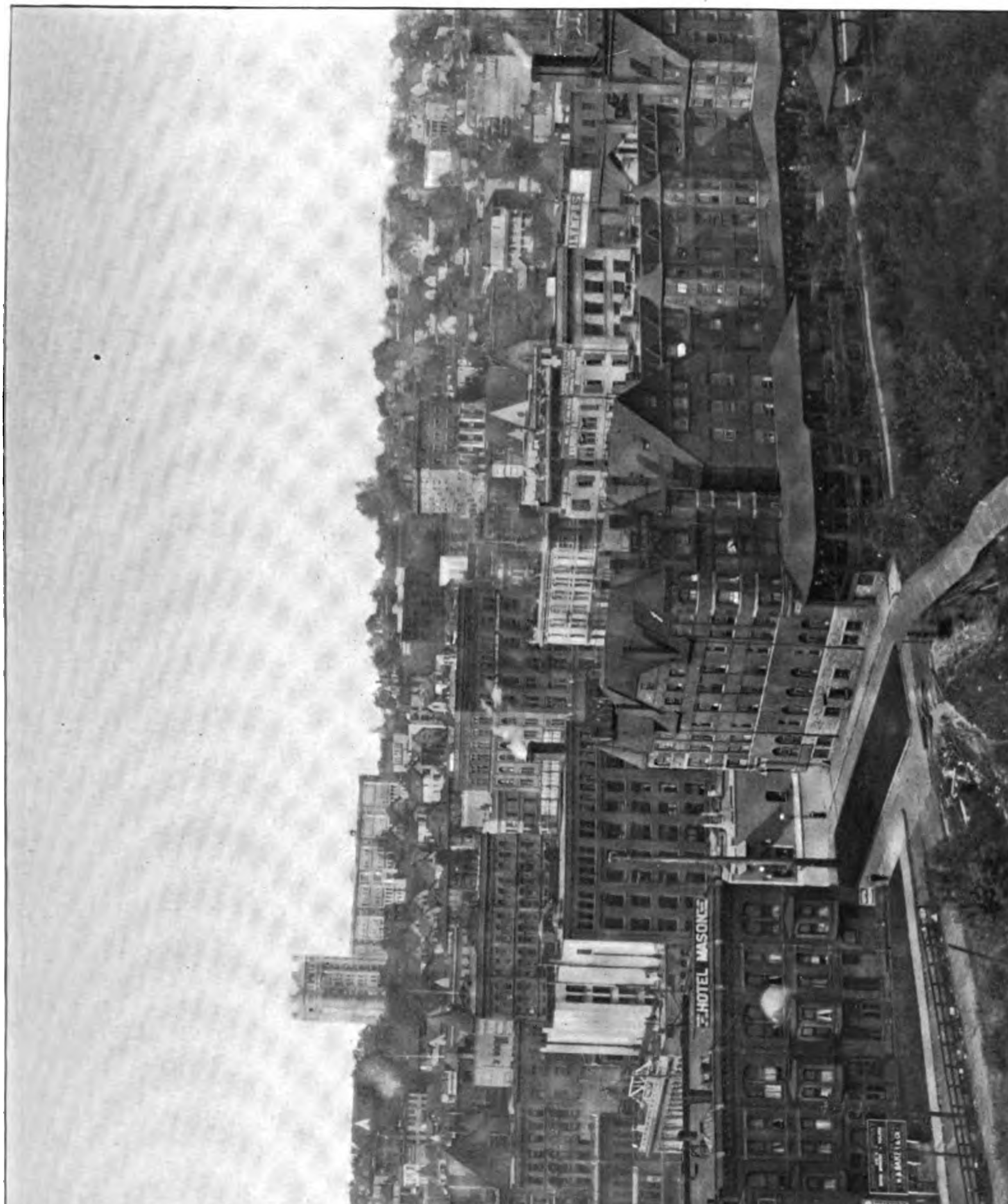
TACOMA, tȧ-kó-ma, Wash., third city in Washington, seaport, county-seat of Pierce County, on Commencement Bay, 38 miles south of Seattle and 25 miles north of Olympia. Its phenomenal growth has given the city the name «The City of Destiny.» It is also called the «City of Beautiful Homes» and the «City with a Snow-Capped Mountain in its Dooryard.» It is situated at the head of navigation on Puget Sound and is the western terminus of the Northern Pacific and the Chicago, Milwaukee and Saint Paul railroads, both of which maintain large ocean docks and car repair shops. Tacoma is also the American terminus for the Osaka Shosen Kaisha, a Japanese steamship line with headquarters at Osaka, Japan. Tacoma's harbor is one of the greatest deep sea harbors in the world and because of its similarity to the Italian city, Tacoma is often referred to as the «Naples of America.»

Topography.— The Puyallup River empties into Commencement Bay within the city limits and is one of five waterways that help make up this modern port. The city is built on rising ground which reaches an altitude of 418 feet above the river. The best residence portion of the city is on a plateau, elevated about 200 feet above the blue waters of the beautiful harbor, and from any portion of this section may be seen stretches of gleaming water losing themselves among the wooded islands; beaches, white, gray and brown, and frowning headlands. The Olympic Mountains stretch along to the west, rugged, snow-flecked and mysterious, while to the east rises Mount Rainier, here known as «Mount Tacoma.» «The Mountain that was God,» as one author calls it, an eternally snow-capped peak, 14,520 feet high. It is but «four hours from Tacoma to the Glaciers,» from tidewater to mountain elevation. The streets of Tacoma are level and paved, and so generously and wisely is the city laid out that it has not a street less than 60 feet wide, while it has several noble avenues 100 feet wide and a few 120 feet. Nearly every home — that of banker, merchant, manufacturer, wage-earner — is surrounded by beautiful lawns, and pretty gardens. The climate is noted for its equableness and mildness, the mean annual temperature being 50.6°; the mean maximum, 58°; and the mean minimum, 43.3°. Rainfall is 43 inches, with little or no snow.

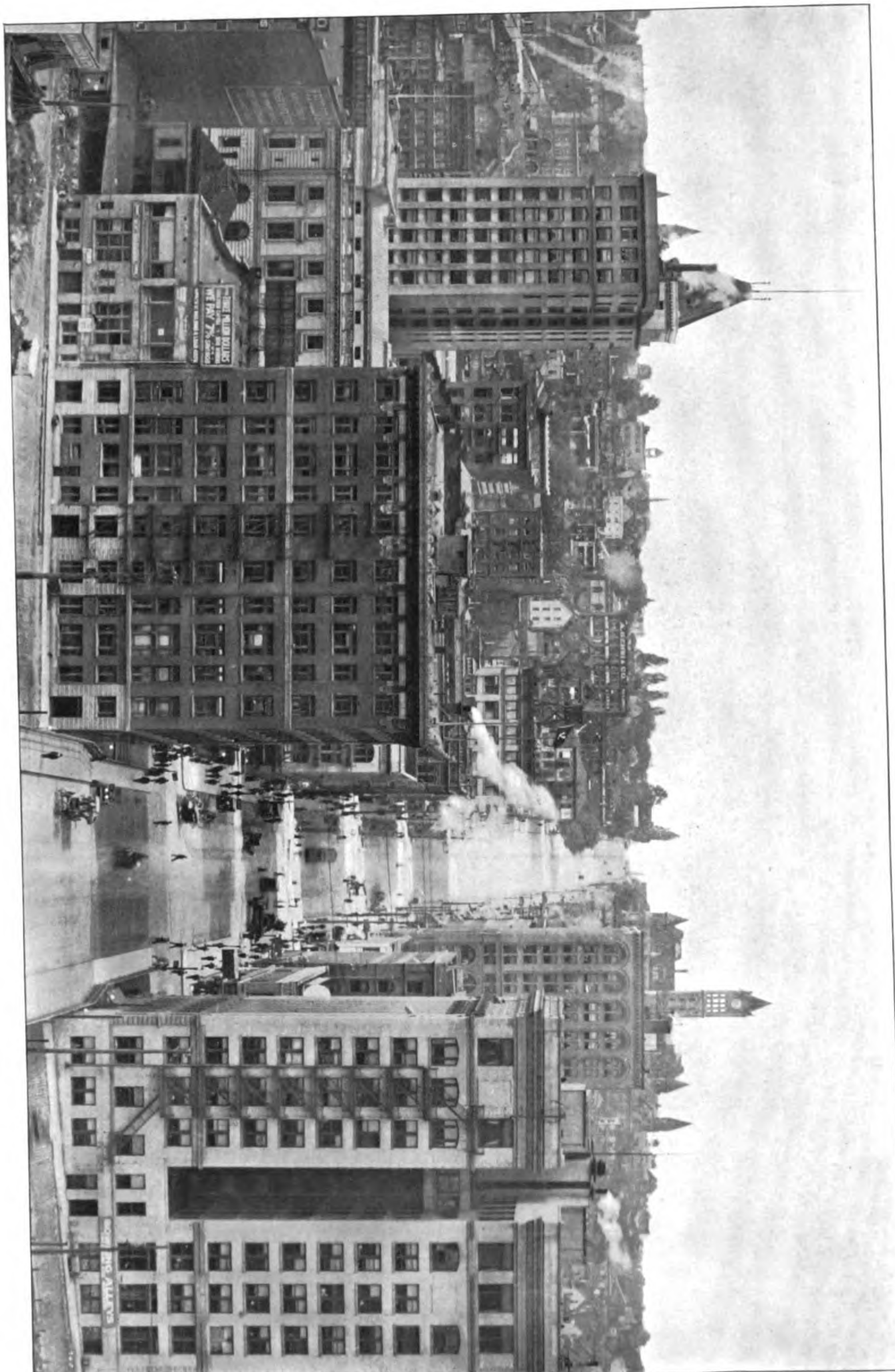
Trade and Commerce.— Because of her strategic position, Tacoma has always commanded a huge water-borne commerce. In 1918 1,666 arrivals from foreign ports were recorded, with cargoes of 2,103,656 tons, while clearances for foreign ports numbered 1,803 with a tonage of 2,103,595. The total value of imports and exports was $318,613,938. Flour exports alone totaled 2,160,474 barrels, valued at $22,747,555. The daily capacity of the flour mills is 9,000 barrels. Tacoma's wheat warehouses have a storage capacity of 8,584,300 bushels. From the time in 1869 when a schooner-load of lumber from the old Hansen mill was shipped to San Francisco, Tacoma has been the leading lumber manufacturing city of the Pacific Coast. There are 52 mills in the district in addition to many allied lumber industries. In 1918 the lumber exports totaled 93,500,000 feet. The principal steamship lines operating to the Orient are the Osaka Shosen Kaisha of Osaka, Japan, and the Pacific Steamship Company's Admiral line. Dodwell's Blue Funnel, among other lines, also operates to Tacoma. Already possessing superior facilities for economical handling of cargoes, including large coal bunkers, electrically operated, a port commission of three, elected by the city following the creation of a port district in 1918, plans the expenditure of millions in construction of new waterways and improving present port facilities. The hub for the southwestern counties of Washington, Tacoma possesses a huge wholesale and jobbing trade. Her jobbing trade in 1918 totaled $160,000,000; retail trade $65,000,000.

Manufactures.— With 1,850 business enterprises, including over 300 manufacturing plants, Tacoma has approximately 58,116 wage-earners, with a monthly pay-roll averaging $6,783,000. The value of manufactured output in 1918 was $152,000,000. Of this amount $27,900,000 represents the value of eight steel vessels and 42 wooden ships launched in the year by six shipyards. In the shipyard industry a maximum of 15,000 men were employed. The Todd Drydock and Construction Corporation alone employs about 8,000 men, and is one of the largest and best laid out steel shipyards in the country. The Tacoma Smelter employing 1,000 men had an output of 156,000,000 pounds of copper valued at $40,000,000 in 1918. This plant refines one-twelfth of the world's copper output. Next in importance, come lumber and its allied industries, including the manufacture of woodware, box shooks, baskets, furniture; and meat packing, flour and cereal milling, candy and food products, marble, iron and steel products, including machinery, boilers and marine engines.

Most of Tacoma's industries are centred on 1,500 acres of tidelands extending the width of the southern boundary of the harbor, the



A portion of the Hotel and Retail District from the Waterfront



A part of the Financial and Retail District from the Waterfront whole interlaced with railroad tracks and roadways.

Banks and Banking.— Tacoma has six national and State banks. At one time there were 10, the decrease being due to mergers of the largest institutions. The deposits 1 Jan. 1919 totaled $38,139,781. The clearings for 1918 were $243,973,348, while the bank transactions amounted to $775,311,157. Postal savings deposits were $1,135,732. The clearing house was established in 1889, and includes all the banks in the city, which own the buildings in which they are located.

Government and Finances.— The city adopted the commission form of government in 1910. Five commissioners, one of them mayor, all popularly elected, serve four-year terms. The city controller is the only other elective official. The police and fire departments are well organized, the fire department being completely motorized. The city owns and operates a $2,000,000 hydro-electric power plant of 32,000 horse-power capacity; a $2,300,000 gravity water system with a 42,000,000 gallons daily capacity; a municipal freight and passenger dock, and a municipal street car line on 11th street serving the industrial district. The total length of paved streets is 110 miles; improved streets, 307 miles; cement sidewalks, 408 miles; sanitary sewers, 224 miles; storm sewers, 339 miles. Assessed valuation (50 per cent of the true valuation) is $59,508,611. The bonded indebtedness, $3,394,000. City power rate is .45 of a cent to two cents per kilowatt, according to load factor, cheapest rate in the country. Private power companies have plants with a capacity of 72,000 horse power, with practically identical rates. The streets of the city are electrically lighted. A single gas plant supplies Tacoma consumers; also those in the city of Olympia. The parks and playgrounds are administered by the metropolitan park board, members of which are elected by popular vote. The acreage of parks is 1,200, including Point Defiance Park and Zoo, 662 acres, and Wright Park, 40 acres. In addition are park areas outside of the city limits surrounding Spanaway Lake, Steilacoom Lake, American Lake, and Gravelly Lake. There are four golf clubs with 18-hole courses.

Public Buildings and Clubs.— Most prominent of public buildings are Federal building (United States Post Office, custom office, internal revenue, and federal court), Pierce County Court House, City Hall, Tacoma building (owned by Tacoma Commercial Club and Chamber of Commerce and Weyerhaeuser Timber Company), National Realty building, 16 stories; Fidelity building, 12 stories; Tacoma Theatre, Jones Block (Pantages Theatre), William L. Davis building, Perkins building, *News-Tribune* building, Tacoma Hotel, Olympus Hotel, Northern Pacific Headquarters building, Rhodes building, Provident building, National Bank of Tacoma building, Bank of California building, Scandinavian-American Bank building, Elks Club. Prominent clubs include Elks, Union Club, University Club, Moose, Rotary Club, Kiwanis Club, all but last two owning their own buildings; Automobile Club, Y. M. C. A., Y. W. C. A., Commercial Club and Chamber of Commerce, Tacoma Country and Golf Club, Lakeside Country Club, Lochburn Golf Club, and Meadow Park Golf Club, Tacoma Yacht Club, Tacoma Tennis Club, Soldiers and Sailors Club.

Transportation.— Six railroads have terminals or connections in the city. The Northern Pacific and Chicago, Milwaukee and Saint Paul railways have their western terminals in Tacoma, including car repair shops, and ocean docks. The Great Northern and the Oregon and Washington (Union Pacific) railroads operate in the city, and the Great Northern has connections with the Canadian Pacific and the Chicago Great Western railroads. Electric interurban trains operate between Tacoma and Seattle on a half-hour schedule; also between Tacoma and Puyallup. There is a total of 143 miles of track operated by the local traction company. Automobile stages on regular schedules operate on a dozen paved highways to every city and town in Pierce County and adjoining counties, including the cities of Seattle, Olympia, Aberdeen and Hoquiam, and Chehalis and Centralia. Local steamers operate to all points on Puget Sound, including Victoria and Vancouver, British Columbia, and to Pacific Coast and Alaskan ports.

Camp Lewis and Rainier National Park.— The largest permanent army mobilization and training cantonment in the United States is Camp Lewis, just south of Tacoma's city limits. The cantonment contains 76,000 acres and is 18 miles long and 12 miles wide. Citizens of Tacoma and Pierce County (the city pays 80 per cent of the taxes) voted $2,000,000 in bonds to purchase the land donated to the government for military purposes. In consequence, a full division of troops will be maintained at the camp permanently. Paved highways with auto transportation lead from the city to the camp. There is also steam and electric railway transportation.

From Tacoma automobiles convey a tourist in four hours over one of the finest paved highways in America to the Glaciers of Rainier National Park and to matchless Mount Rainier (or Tacoma, its local name), 14,520 feet high. The park is the most popular of those supervised by the United States government. Attendance in 1918 was 50,000, exceeding that of any other national park. There is transportation to the park over the Tacoma Eastern to Ashford from Tacoma, giving rail transportation to within a few miles of the park entrance.

Education.— Tacoma is the seat of the College of Puget Sound (Methodist), Pacific Lutheran Academy (Lutheran), Annie Wright Seminary (Episcopal), Academy of the Visitation and Aquinas Academy (Roman Catholic). There are eight parochial schools, six commercial or business schools, and in the public school system two magnificent high schools and 32 grammar schools. The total enrolment of the public schools is 18,904, including 2,000 attending night schools. There are 645 teachers employed. The Stadium High School has a Greek amphitheatre called Stadium which has a normal capacity of 32,500 persons, which can be increased to between 40,000 and 50,000. The Carnegie Library, with two branch libraries and branches in the high schools and grammar schools, has 85,598 volumes with a net circulation in 1918 of 338,237. The total value of library property is $200,000, and the number of registered borrowers 18,111. Overlooking the Stadium and opposite the high school are the Ferry Museum, with a large collection of Indian curios and pioneer relics, and the stately home of the Washington State Historical Society.

Churches and Charities.— Nearly every religious sect or denomination has a house of worship in Tacoma, the city being particularly well equipped with beautiful churches, the total number reaching 135, the principal denominations being Methodist Episcopal, Presbyterian, Lutheran, Episcopal, Congregational, Roman Catholic, Baptist, Christian Science, Christian, Jewish, Evangelical, Friends, Adventist, United Presbyterian and Universalist; also Salvation Army and Volunteers of America.

Charitable institutions include the Northern Pacific Hospital, County Hospital, Tacoma General Hospital, Saint Joseph's Hospital, City Contagious Hospital, Western Washington Hospital for the Insane at Fort Steilacoom, a suburb; the Children's Home, City Rescue Home, Parkland Children's Home.

History.— Tacoma city was originally within the boundaries of the first ward, popularly known as Old Town, now called Old Tacoma. The city was laid out in 1868 by Gen. M. M. McCarver. In July 1873 the Northern Pacific Railroad established its Pacific Coast terminus on Commencement Bay, giving it the name New Tacoma. The city was also called Commencement City. In 1880 the new town became the seat of Pierce County, and in 1883 Old Tacoma and New Tacoma were consolidated and incorporated as a city. Since that time additional territory has been annexed on four different occasions, giving the city a total of five taxing districts. The present area of the city is 25,168 acres of land and 2,752 acres of water, or 39.81 square miles. The distance from northern to southern boundary is seven miles. The 35 wharves and docks have a lineal frontage of six miles.

Population.— Government census (1880) 720; (1885) 1,100; (1890) 36,006; (1900) 37,714; (1910) 83,743; (1 Jan. 1919, local estimate) 142,447.

Edward P. Kemmer,
Managing Secretary of the Tacoma Commercial Club and Chamber of Commerce.

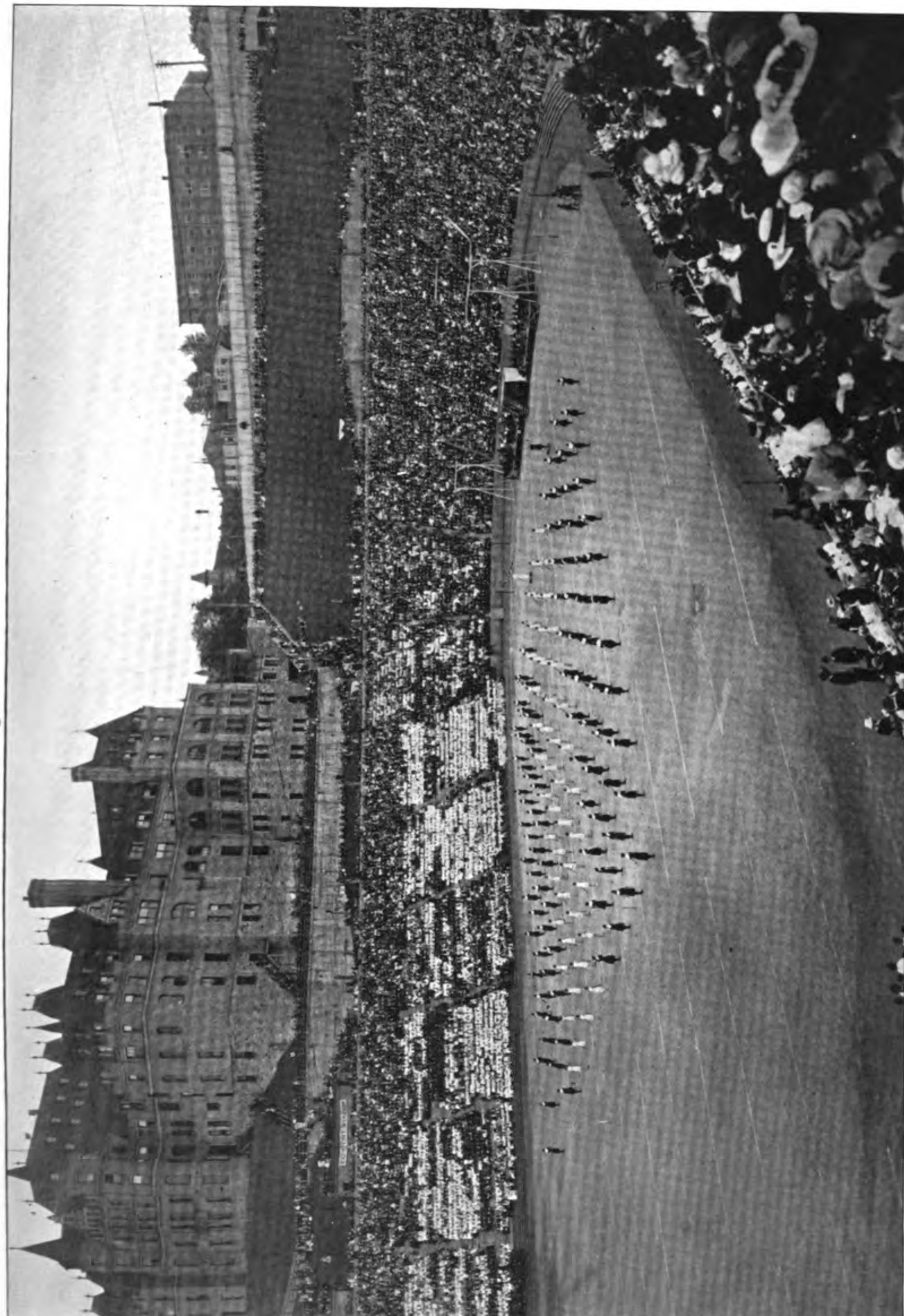
TACONIC (tą-kŏn'ĭk) **MOUNTAINS**, a range extending nearly north and south, uniting the Green Mountains of western Massachusetts with the Highlands of the Hudson. The highest peaks are Equinox in Vermont, 3,847 feet, and Greylock in Massachusetts, 3,305 feet. The Taconic system, in geology, was named from the characteristic strata of this range, a metamorphic rock, believed to be older than the Silurian system.

TACONIC SYSTEM, a term applied by Prof. Ebenezer Emmons, in 1842, to certain azoic and palæozoic rocks occurring in the eastern part of New York and western parts of Vermont and Massachusetts. These he believed to be the equivalents of the Cambrian rocks of England. Subsequent investigations have shown that Emmons misread the geological structure of the regions studied by him, and his arrangement of the strata has, therefore, been set aside. The subject has given rise to much discussion among American geologists. Consult Emmons, 'Geology of New York,' 'American Geology,' and 'The Taconic System'; Marcou, 'On the Use of the Name Taconic'; Walcott, 'Taconic System of Emmons'; Winchell, 'Some Objections to the Term Taconic'; Dana, 'History of Taconic Ideas' (in *American Journal of Science,* 3d ser., Vol. XXXVI, 1888).

TACTICS. Tactics has regard to the evolutions of an army in the actual presence of an enemy, and may be defined as the strategy of the battlefield or the science of manœuvring and combining those military units which drill, discipline and the regimental system have brought to the perfection of machines. It was admirably described by Napoleon as *the art of being the stronger* — that is, of bringing an overwhelming force to bear on any given point whatever may be the relative strength of the entire armies opposed. The earliest records of battles are those of mere single combats, in which the chiefs, fighting either on foot or in chariots, performed great deeds; and the commonalty, who apparently were without discipline, were held in profound contempt. With the growth of democracy arose the organization of the phalanx, the advance of which was irresistible; and its firmness equally so, if charged in front. It, however, changed front with great difficulty; was much deranged by broken ground; and failed entirely in a pursuit, or if attacked in flank. Far lighter, more mobile was the Roman legion. Among Roman tactics was also the admirable intrenchment, which they scarcely ever omitted as an additional source of strength for their position.

Events reproduce themselves in cycles; and with decay of Roman civilization came again the mail-clad heroes and cavaliers — mounted this time on horses — who monopolize the honors of battle, while the undisciplined footmen had an undue share of the dangers. Later in the feudal period, this disparity between knight and footmen was diminished by the employment of bodies of archers, whose shafts carried distant death. The adoption of gunpowder for small arms altogether neutralized the superiority of the armored knight. This change brought infantry into the front place in battle, and threw cavalry into the status of an auxiliary. The French Revolutionary Wars tended much to the development of artillery as a field weapon and Napoleon employed this terrible engine to its fullest extent, a practice followed by the best modern generals, who never risk a man where a cannon ball can do the work. Frederick the Great was considered an innovator for fighting with infantry four deep. During the French war, the formation of three deep became general. Before the battle of Waterloo, the British leaders had acquired sufficient confidence in their troops to marshal them in a double line.

In the battles of Gravelotte and Sedan, the turning tactics came prominently forward. At Sedan the turning movement was complete. The losses of the tenth German division at Wörth prove what a serious matter it is to make a direct attack against the breech-loader. They amounted to about 4,000 men. It was of course necessary to make vigorous attacks on some points of the French position, so as to take



Tacoma High School Stadium, built of solid concrete. Seats 40,000 persons. View taken during Stadium Day exercises

off their attention from the circular enclosing movement of the Germans. Although they (the Germans) were frequently obliged to make front attacks, the principle of the turning movement always asserted itself. In any case, however, a direct infantry attack should always have been undertaken in sufficient force. But this was too often not the case, so that weaker forces exposed themselves to suffer great losses in long-continued doubtful conflicts, gaining at the same time but little ground.

On the defensive the shooting-tactics of the Germans consisted simply in firing at short range, a practice which always had the best results. The main position selected was generally strongly occupied in first line. It was rightly judged that a strong development of fire at the commencement of an action was necessary and advisable. Separate strong masses in reserve, not a great many little reserves, were formed. If there was sufficient time, the position was divided into sections and prepared for defense as well as possible. On the approach of the enemy the artillery was at once deployed into a connected line. The cavalry, having at first been pushed forward to check the enemy's advance was then withdrawn behind the line of defense.

To sum up the characteristic points of the infantry battle-tactics of 1870–71, it will be necessary in doing so to mention in the first place what we did *not* see. That is to say, *no* volleys in battle; *no*, or at least a very few, attacks by troops in close order; if, however, a compact body ever did attack, it was always a small one, never amounting to a battalion column. But we *did* see great deployments of skirmishers on both sides; long continued gradually advancing musketry fights, often rolling backwards and forwards; at last the flank of one party turned or else one side exhausted; the other side pressing on in consequence, or a rush of dense clouds of skirmishers who endeavor at any price to dislodge their opponents; not forgetful that, in case of failure and retreat, they are *dead* men. On both sides great dispersion; intermingling of troops and particularly in broken ground; hence the leader's control diminished. With the Germans — more steadiness and the habit of reserving their fire. With the French — more hurry and the habit of firing at long ranges. However great the effect of the artillery; however enormous was the loss of the French by shells, there was still no example of a really great result being due specially to artillery. Even the plateau of Floing, which was cannonaded from all sides, had to be stormed by infantry. And the same may be said of Saint Privat.

The instances which have been given are the principal assaults in the first half of the war; they present many points of resemblance. In nearly every case the troops were drawn up in two lines of company columns and a reserve. The skirmishers were sent forward, the first line followed at 150 or 200 paces distant and then the second line. In no instance, however, does it appear that there was more than one line of skirmishers; behind them the troops marched with dogged bravery, in solid line of two ranks, shoulder to shoulder, or in company columns with platoon fronts far inside the line of rapid effective fire; and they continued this march until the fire caused a break in their lines and a retreat, or until they reached the work after enormous losses and held it as the result of a hand-to-hand fight. The skirmish line was so small in comparison with the main force that it really amounted to nothing and the attack was in fact made in solid line. The attack and the forward movement were not distinguished. This *defective* formation was the principal cause of the heavy losses.

In offensive tactics we may consider three general modes of attack, one of which the commander of a combined force must select as the most suitable for his purpose. (1) *Frontal attack*, which would mean a direct advance upon the whole of the enemy's line or position. As a general rule, this form of attack is unadvisable, as even in case of success the result is not decisive; the enemy's line of retreat being unassailed, he simply falls back to a position more to the rear. There may, however, be situations when the nature of the ground prevents any other mode of operation, or where the frontal attack may be made use of to feel the enemy and ascertain his exact dispositions, in preparation for a concentrated attack upon one of his weak points, as soon as they are discovered. (2) *Combined attack upon front and flank*. In this case the enemy is attacked in front at the same time that a portion of the force is directed at one of the flanks. An attack upon the flanks by itself unaccompanied by a front attack is not advisable, except in the case of small detachments acting against one another, or unless the attack can be effected by surprise, in which case the enemy is unable to meet it in time by a change of front. Were a strong force in position attacked solely on the flank it would quickly form up its reserves to a new front, the troops of the original front coming up in support. For a flank attack, therefore, to succeed, it must, as a general rule, be accompanied by a frontal attack, sufficient to hold the enemy to his original position. An attack upon both flanks combined with a frontal attack can only be tried under circumstances of great superiority of numbers, without which it would become a most dangerous operation, enabling the enemy to give the counter-stroke of a weak point of a straggling line and beat the assailants in detail by cutting their force into two. In engagements where the numbers are small the flank attack may be made alone. (3) *Concentrated attack upon a weak point*, to break through the enemy's line or force his position. This mode of attack, if the most difficult of execution, is undoubtedly in case of success the most decisive, the enemy being broken into fractions which can subsequently be beaten in detail. The enemy's line of retreat may also thus be arrived at, and his communications cut before he can recover himself. The attack must always be made with force sufficient to resist a counter enveloping attack on the part of the enemy; which might otherwise be disastrous in its results. The increased range of modern guns and rifles has made this attack more hazardous than ever, for a concentrated fire-action can now be brought to bear on the assailant, not only from all parts of the defense in his immediate front, but in most cases from either flank as well.

Unless, therefore, the ground covers the movement in a great degree it should not be attempted.

In addition to the above primary modes of attack, a *turning movement* may also be considered. This might be looked upon as almost a form of flank attack were it not that it differs from it in some essential particulars. The turning movement is more often a *menace* than an *attack* for it threatens the enemy's line of retreat so as to force him to change front or shift his position before he enters the combat. The manœuvre differs also from a flank attack inasmuch as it removes the scene of combat from the position held by the enemy, while the flank attack takes place on one of the flanks of the position itself. The turning movement may be made, either with a portion of the force at command, or with its whole strength. In the first case, the conditions should render it improbable if not impossible that the enemy could act offensively in turn upon each fraction of the divided force. Otherwise the separate movement should not be attempted, as it must end in disaster. When the ground permits, or is favorable, cavalry and horse-artillery are specially suited to the turning movement. They should, therefore, nearly always form a portion and sometimes the whole of the troops employed in the service, both because they can by rapid advance produce the moral effect of surprise, and because they can more easily avoid destruction by a superior force.

The commander of a small force of the three arms should have no difficulty in preparing his plan of attack and issuing his orders, upon receiving reports of the strength and dispositions of the enemy and of the nature of the ground upon which he must act. In ordinary cases when small forces are engaged, the cavalry, which reconnoiters in advance, will bring in sufficient information for the purpose; but if the enemy should be covered by advanced troops, it may be necessary to make a special reconnaissance, sometimes supported by guns, in order to arrive at a knowledge of his strength and intentions. With large forces this would probably be carried out by the advanced guard the artillery of which, re-enforced where necessary from the main body, would take up what may be called a *preliminary artillery position* and open fire at long range to cover the advance of the troops employed in the reconnaissance. The information required being obtained, the commander would issue his orders. In the case of very small operations or of a sudden encounter with the enemy these would be given verbally; under other conditions orders should, if possible, be written. Should the force, as it probably would, consist of detachments under various commanders, it would be necessary that there should be a *general order* for all, and also a *special order* addressed to each commander where separate action is required. The general order should be clear, precise and complete, and as short as quick compliance with these requirements will permit. It should contain:

1. The conditions or circumstances of the intended action with what is known of the enemy.

2. The mode of action determined upon, and how to be undertaken; thus for instance, to attack the enemy when he is touched on in direct advance, or, to attack the whole, or a certain part of a position.

3. The strength, composition and general division of the attacking force, with names of commanders; this may be given more in detail in the margin of the order if thought necessary.

4. The preliminary positions to be taken up by each distinct part of the force with their directions of attack.

5. The hours at which these positions are to be assumed, and at which the forward movement or attack is to be commenced.

6. The position where the commander of the troops will be found during the action, to which all references or reports are to be made or sent.

These clauses would be sufficient for a small force, but in operations of greater magnitude it would be necessary to add:

7. The positions of the ambulance and field hospitals, and the order of march of the trains of the various columns.

It must be understood that the dispositions of the troops thus indicated are only intended for the first phases of the engagement, for, until the enemy's counter-plans are developed, the final movements which depend thereon cannot be defined. The special orders addressed to separate commanders should contain nothing that may tie their hands too much in matters of detail. As a rule, they should be told the thing to do, not the manner of doing it, and within safe limits, to be named, they should be allowed free action.

For the purpose of watching the phases of the combat, the position which the commander should assume during the engagement ought, if possible, be on an eminence, from which he can perceive the principal portion of the ground over which the troops are to work. He should not quit this post (duly announced in the "order") without exceptionally good reasons, and if he is obliged to do so, an officer should be left behind to direct all reports or messengers to the new station of the commander.

The orders which are necessarily transmitted during an action by the commander of the troops are of much importance and should be given with great care. They should, if possible, be in general harmony with the original plan of attack, although certain modifications may become necessary. They should not descend to details which are better left to commanders of corps, nor should the commander of the troops interfere in the execution of his orders, further than to assure himself that they are carried out. He should be satisfied on this point by means of constant reports and communications which must be kept up without interruption during the action between him and the commanders of separate corps and detachments. When the reports cannot be sent by an officer, they should be written, and in such case be numbered and dated with the exact hour and minute of dispatch. Above all other matters it is most important that the commander of the troops should be immediately informed when circumstances render it impossible for a subordinate commander to carry out the orders or instructions, as the failure to execute these may necessitate modifications and fresh orders to replace the former ones.

By the end of the third stage it may be presumed that the enemy has been forced to show his hand sufficiently for the purposes required of determining the best method of finally attacking him, and the commander's main dispositions are either directed to be carried out in their original design or else modified to suit new ascertained conditions.

The artillery, which up to this time has continued from its first position to support the general advance, by endeavoring to silence the enemy's guns and to draw off his fire from the infantry, is now directed to deliver barrages and to concentrate its fire upon the intended point of attack in order to prepare the way for the infantry assault. The moral effect of this fire upon the defenders will probably be very great, even if the physical effect upon troops partly behind cover of ground and obstacles be comparatively trifling.

Whenever the ground will admit, the infantry are supported on the flanks by cavalry, which advances under cover in small columns, with strong supports close at hand, and losing no opportunity of attacking any advanced troops of the enemy and warding off adverse attacks in return. The very fact of the cavalry occasionally showing itself on the flanks gives confidence to the attacking infantry and demoralizes the defenders, especially if they are themselves deficient or weak in that arm.

The fourth stage is now commenced, by the infantry being firmly launched at the selected points of attack, and it comprises the whole of the real action up to the moment which immediately precedes final success or failure.

The infantry here plays the principal part. It is fairly committed to the fight and having received its final impulse in the desired direction from the commander of the force, no power can alter or recall it, for good, during the remainder of the engagement. Its development of fire-action should rapidly increase as it nears the point of attack, for upon its weight of fire depends its success.

The cavalry on the flanks should be on the watch, not only to protect the infantry flanks of its own troops extended in the advance, but also to seize opportunities of approaching unseen the flanks of the opposing infantry or artillery, and of throwing them into disorder or demoralizing them, if not inflicting serious injury. If repulsed and in its turn disordered, it must rally under the protection of other arms, and again return to exercise similar functions. But cavalry at this stage can only play a minor part, unless the ground be more than usually favorable to its action; with the exception, therefore, of strong supports to the cavalry acting on the flanks, the remainder of this arm would still be kept in reserve, but not so far to the rear that it could not be brought up quickly if required to make a diversion or demonstration on either flank.

The artillery, which during the former stages has been of first importance on account of its long range, now falls into the second place. The circumstances of the case must determine whether it shall keep up its fire on the enemy's guns to relieve its own infantry, or whether it shall fire on the enemy's troops. As the rule to be followed is, that it shall fire on that arm of the enemy which is for the time the most important, the enemy's infantry will in all probability be now the object. In either case, a moment may arrive during this stage when a second position more in advance is necessary for the guns, on account of their fire becoming masked by their own advancing infantry. If a portion or the whole of the guns can, in such case, be advanced rapidly and placed in a good position (especially on a flank, whence they can add their own fire to that of the advancing troops, which are at the moment absorbing the whole attention of the defending infantry), the proximity to the enemy's line, of this *second principal artillery position,* must not be too much limited by ordinary rules of caution. When the attack and defense are nearly matched, it is clear that the addition of a close artillery fire on either side may turn the scale and compensate by decisive success for any loss sustained. As this close action of guns may in case of repulse lead to confusion, it would perhaps be advisable that the whole of the available artillery should not take up this second advanced position, but that a portion be held in reserve, massed in a favorable position, and be kept in action all the time in support of the advanced battery.

If the attack is successful and the enemy retires either before the demoralizing influence of the last steady advance, or broken by actual assault, the position he occupied is quickly assumed by the artillery and a heavy fire brought to bear on the retreating troops. The reserve cavalry, which by this time has been brought up from the rear, and probably posted on the weaker flank is now launched in pursuit accompanied by horse-artillery, the superior mobility of both rendering their use peculiarly well suited to this service. The commander of the troops would move forward from his station, and take his post upon the position lately occupied by the enemy, for further direction of the movements. The infantry meantime would recover from its first confusion, reform its ranks broken by the assault, and then furnish from its freshest troops, in all probability the reserves, a force to aid in the pursuit. The field-batteries will also push forward and harass the enemy with their fire, when he gets out of range of the position or becomes masked in his retreat by the interposing troops in pursuit.

If, on the other hand, the final assault of the position has been unsuccessful, the attacking force must retire, covered, in open ground by the cavalry and artillery, in close ground by the least disorganized portion of the infantry supported by the artillery. The latter arm now plays an important part. It must run every risk to enable the retreat to be safely effected, until a rearguard can be organized to protect the movement. With this view, the first position where a stand can be made close to the field of action must be taken up by the freshest of the infantry, and the guns must be posted in such manner as not only to support the infantry, but further to cover all the necessary dispositions for conducting the retreat in good order.

Should a commander of a force of the three arms decide to stand on the defensive, he should take up the position most suitable for his purpose without delay, as the superiority to be attained by this course of action must result in great measure from the advantages attendant upon choice of ground. A good position should be such, from a tactical point of view, that the different arms could be disposed for defense in the manner most suitable to their action and that there should be facilities for concealing their strength, composition and posts from the view of the enemy, and of preserving them more or less from his direct fire during the attack. It is also of the highest importance that the front of any position selected for defense should be clear for view and fire, as should also be the flanks, unless they rest on impassable obstacles.

The first stage of the defense which was commenced with the reconnaissance of the enemy would thus comprise the selection and occupation of the position by the defenders, as well as the advanced action, if any, of the artillery, already alluded to. Upon the selection of the ground most suitable for the artillery of the main position, will in great measure depend the exact trace of the fighting line for the infantry, the positions for the guns so much depending upon the circumstances of each case, and more especially upon the configuration of the ground. The guns of the position should, however, if possible, be so placed as to bring the enemy's columns under fire at long range, and hence they ought to command every distant approach. They should also be able to pour a concentrated fire upon the probable positions which will be assumed by the attacking artillery, and be stationed so as to sweep the ground in front of the position from the earliest to the latest moment of attack. The defense of the flanks in the case of large forces must be specially provided for.

It would, therefore, appear that, unless the ground is peculiarly favorable for posting guns in flanking positions, where without being exposed to enfilade they can bring a cross fire to bear upon the main attack, and a flanking one to protect the immediate front, the required conditions can only be fulfilled by the guns being placed in the front line and preferably at the salients, should an irregular contour mark the front of the position. The general distribution of the infantry would probably be in three lines; the first or fighting line of defense, the special supports, and the reserves. If time for hasty fortification is permitted some sort of entrenchment should be always prepared for the batteries, as even a low parapet of earth gives protection to the gunners. Great care should, however, be taken that the newly broken earth is concealed or covered in such a manner from the enemy's view, that it shall not serve as a mark for their artillery more distinct than would otherwise be presented by their guns alone. Shelter-trenches may also be prepared for the infantry in the fighting and supporting lines. Neither the places prepared for the batteries nor the shelter-trenches should be occupied by the guns or troops till the proper moment for action arrives.

In making these arrangements, it is of the utmost importance to secure the artillery of the main position against the fire of the enemy's advanced skirmishers or marksmen; and with this view, the batteries ought to be covered in their immediate front by a line of extended riflemen, placed either in trenches or pits or behind natural cover, at a distance of from four to five hundred yards in advance of the guns which they defend. If the battery is on a flank, this protection should also be extended for a similar distance to the flank. The infantry thus posted would remain as long as possible in position, and only retire when, at the final stage, they are driven back by the overwhelming advance of the assailants. Besides their principal function, of keep-off the enemy's skirmishers from too early approach to the batteries of the defense, these advanced infantry could often bring an irritating fire to bear upon the attacking artillery at its first principal position, and perhaps serve to prevent the guns from approaching to the most telling ranges. This possible action would of course depend much upon the features of the ground.

It is impossible to lay down any rule for the exact position of the artillery of reserve. High ground near the exposed flank, provided facility of movement therefrom in case of necessity is presented by its features, would often be suitable. The guns should, however, in any case be well up to the front, so as to lose no advantage of range from the commencement of their fire. A position in rear which entails not only a sacrifice of some hundreds of yards range, but the necessity of firing over the heads of the defending infantry, greatly to their discomfort and demoralization, does not appear to present commensurate advantages of safety to the guns. It is evident that artillery so placed would be comparatively useless during the later stages of the defense, when once the attacking infantry has advanced so close that the fire of the retired batteries would be masked by the ground, or by the defending infantry lining the position. Guns so placed might be useful in defending an inner line, or for supporting a counter-stroke delivered inside the position after the assault has been made, but their action would be lost almost altogether during the period immediately preceding the final attack of the position. The previous knowledge of ranges and distances, possible to the artillery of the defense, presents a great advantage; but if circumstances have not permitted the gunners to ascertain them during the preliminary arrangements, by aid of range-finders, aeroplanes, or other means, the earliest portion of the artillery action must be utilized to obtain correct estimates of the ranges to all important points, by means of trial shots.

There are certain points or portions of all positions, the possession of which would assure the assailant the greatest tactical advantages. In many cases also the conformation of the ground appears to limit the movements of an enemy to certain lines of operation. The defense should, therefore, occupy these parts of the position in force, with supports in close proximity, while still preserving the general line. Under the second condition the force should be prepared to resist advance by rapid re-enforcements at any of the possible points of approach. The reserves of the third line should be placed so as to be available for strengthening the most likely points of attack and to be able to protect the line of retreat. Most of the cavalry, and some horse-artillery if it can be spared, would be placed with the reserves. Sometimes a portion of this force is placed in the second line for the purpose of joining in forward movements and flank attacks upon the assailants, or of covering the retreat of the troops engaged in these counter-attacks if unsuccessful.

The second stage generally commences with the opening of fire at long range from the main batteries of the position, upon the heads of the enemy's infantry to quit its order of march and deploy. The attacking artillery will probably now reply from its first principal position, and as the artillery of the attack is at this time the most important arm it must be answered by the guns of the defense. In this artillery duel the defenders should have the advantage, as knowing accurately the ranges to the various points which must be occupied by the enemy in his advance, and as being moreover entrenched while the assailants are all comparatively exposed. During the second stage the infantry of the defense are brought up into position and open long-range fire upon the advancing enemy with more or less effect.

In the third stage the advance to effective rifle range of the attacking infantry has forced the defense to show more clearly the positions for the real attack, the direction of which it is now the object of the defending commander to discover, by every means in his power. As the supports and reserves of the assailing infantry come clearly into view, they should receive the concentrated fire of part of the artillery of the defense.

In the fourth stage the real point menaced by the attack being made clearly apparent, the commander re-enforces it to meet the assailants with a superior fire, and the artillery of the defense is directed at the opposing infantry; which now has become the principal arm in the attack. Should a counter-attack be projected it takes place during this stage, unless it is to be delayed until after the assault. Resistance to a flank movement of the attacking troops would also now have to be made. In the case of a counter-stroke being delivered by the defense, part of the cavalry and horse-artillery might be employed in support of it. Cavalry also should generally move forward on the flanks at this part of the action to seek for opportunities of throwing the flanks of the attacking infantry into disorder, or of taking guns too rashly advanced.

The fifth or last stage comprises the final repulse of the attack upon the position or the defenders' enforced retreat therefrom. In either case pursuit by the victors may ensue. Immediately before and during the final advance or assault every gun of the defense should concentrate its fire upon the attacking infantry, in order to check their advance, and should the assailants retire, the guns must continue to fire upon them, until masked by interposing troops sent forward in pursuit. Should the defenders, on the other hand, be forced to fall back, guns must cover the movement and enable the infantry to disengage itself.

The underlying idea of all infantry tactics is to close with the enemy as soon as possible and with all the units well in hand. The ideal conditions would be those making possible a quiet, quick and orderly advance without halting to open fire, but this is impossible with the highly developed weapons of to-day, and even though some of the attacking infantry managed to close with the enemy, there would be too few left for a bayonet fight. Therefore in order to make a successful assault, the infantry must move up under covering fire. To provide this protecting fire, it has equipped itself with the pistol, bayonet, and high-powered rifle, the one-pounder, trench mortars, the effective hand and rifle grenades, and has called to its assistance its supporting arm — the artillery. The enemy, attempting to protect himself from the terrific fire he knows will precede the infantry attack, has prepared deep dugouts and bombproofs, in which he often hides until the last possible minute.

Despite the fact that all of the above preparations are simply to give the bayonet man a chance to use his weapon (and to kill as many of the enemy as possible while doing it), it follows that fire action is more important than shock action, for without the fire the shock would be impossible. Therefore, the bayonet men must know how to shoot their rifles and to co-operate with the machine gun, the grenade, and the artillery, and must be so formed that during the assault they can deliver an effective rifle fire, present a solid front to the enemy in the bayonet charge, and be close enough to furnish mutual moral and physical support.

The wave attack that has been used so much in France was produced in order to furnish the greatest amount of mutual support among automatic riflemen, grenadiers, the one-pounders and riflemen, and at the same time to allow the greatest number of riflemen (bayonet men) to close with the enemy in the best formation possible. All of the conditions so far discussed make it imperative that the assaulting troops be perfectly organized and that they follow their covering fire (barrage) as closely as possible.

EDWARD S. FARROW,
Consulting Military and Civil Engineer.

TACTICS, Naval. See NAVAL TACTICS.

TACUBAYA, tä-koo-bä'yä, Mexico, a city in the federal district, situated three miles southwest of Mexico City. It is the principal pleasure resort of the valley of Mexico, and has many fine buildings and gardens. The national observatory is situated here, as well as the castle of Chapultepec. Pop. about 40,000.

TACULLI, an American Indian tribe of the Athapascan family, residing in British Columbia, at the headwaters of the Peace and Fraser rivers. They numbered about 750 in 1918 and lived on various small reservations. The majority of them are Roman Catholics, having been converted by French missionaries.

TADEMA, tä'dĕ-ma, **Laurence Alma.** See ALMA-TADEMA, LAURENCE.

TADOUSAC, tä-doo-zäk', Canada, a town in Chicoutimi and Saguenay County, Quebec, situated at the confluence of the Saguenay River with the Saint Lawrence. It is a summer resort, and noted as being the oldest settlement in Canada. It was one of the early centres of the fur trade, and the home for a time of Father Marquette. Remains are still visible of one of the early Jesuit establishments. Pop. 2,500.

TADPOLES. See FROG.

TAFILET, tä-fē-lĕt', or **TAFILELT,** Morocco, an oasis on the southern border of Morocco and northwestern border of the Sahara region, 200 miles south by east of Fez. It covers about 530 square miles, and has a population of about 125,000, distributed among about 150 villages, of which Abuam is the most important. The date-palm is cultivated, and silks and rugs are manufactured.

TAFT, Alphonso, American jurist: b. Townshend, Vt., 5 Nov. 1810; d. San Diego, Cal., 21 May 1891. He was graduated from Yale in 1833, became a tutor there and was admitted to the bar in 1838. In 1840 he settled in Cincinnati and took part in politics, being a member of the Republican convention in 1856. In 1865 he was appointed judge of the Superior Court of Cincinnati, serving until 1872, when he resigned to resume his law practice. On 8 March 1876 he was appointed Secretary of War but after two months was transferred to the post of Attorney-General. During 1877–82 he practised law in Cincinnati, and in April of the latter year was sent as Envoy Extraordinary and Minister Plenipotentiary to Austria. From 1884 to August 1885 he was Minister to Russia.

TAFT, Charles Phelps, American lawyer and editor, half-brother of President Taft: b. Cincinnati, Ohio, 21 Dec. 1843. He was graduated at Yale University in 1864, and later studied at the universities of Heidelberg, Berlin and Paris. He was admitted to the bar of Ohio in 1866 and in 1869–70 was engaged in practice in Cincinnati. In 1879 he became the principal owner of the Cincinnati *Times* which in 1880 he consolidated with the *Star* as the *Times-Star,* of which he has since been editor. He was a member of the Ohio House of Representatives in 1871 and served in Congress in 1895–97. He was presidential elector-at-large from Ohio in 1904, and president of the Ohio electoral college in January 1905.

TAFT, Henry Walters, American lawyer, brother of President Taft: b. Cincinnati, Ohio, 27 May 1859. He was graduated at Yale University in 1880 and later studied at the Cincinnati and the Columbia Law Schools. He was admitted to the bar in 1882 and engaged in practice in New York, where he is a member of the firm Cadwalader, Wickersham and Taft. He was special assistant to the Attorney-General of the United States in the tobacco trust investigation. He was a member of the New York board of education in 1896–1900; a trustee of the College of the City of New York in 1903–05; and since 1908 has been a trustee of the New York Public Library. In 1907 he was appointed chairman of the Permanent Legal Advisory Board for Greater New York under the selective service regulations.

TAFT, Lorado, American sculptor: b. Elmwood, Ill., 29 April 1860. Of English ancestry, settled about 1679 in Mendon now a part of Uxbridge, Mass., his father was Don Carlos Taft, professor of geology, University of Illinois (1872–82), later banker in Hanover, Kan. He graduated B.S. 1879, and M.L. 1880 at the University of Illinois; and studied at the École des Beaux Arts, Paris (1880–83). He opened a studio in Chicago in January 1886; from 1886–1907 was instructor and since lecturer at the Art Institute of Chicago University, extension lecturer University of Chicago (1892–1902) and since 1902 professional lecturer on the history of art. He won the designer's medal at the Columbian Exposition, Chicago (1893); silver medal, Pan-American Exposition, Buffalo (1901); gold medal, Saint Louis Exposition (1904); silver medal, Panama-Pacific Exposition (1915). His work and lectures exercised a wide influence and in 1913 he received the honorary L.H.D. degree from Northwestern University. He is the author of 'The History of American Sculpture' (New York 1903), and of 'Sculpture of the Nineteenth Century' (1919) in the encyclopedia. Among his notable works are 'Sleep of the Flowers'; 'Awakening of the Flower'; Decoration of Horticultural Building, Columbian Exposition; 'The Eternal Silence,' Graceland Cemetery, Chicago; 'Solitude of the Soul,' Art Institute, Chicago; 'Blackhawk,' Oregon, Ill.; 'Washington,' Seattle, Wash.; 'Paducah,' Paducah, Ky.; 'Trotter Memorial Fountain,' Bloomington, Ill.; 'Columbus Memorial Fountain,' Washington, D. C.; Ferguson, 'Fountain of the Great Lakes,' Grant Park, Chicago; Ogle County 'Soldiers' Monument,' Oregon, Ill.; James Whitcomb Riley medal; 'The Fountain of Time,' Chicago; Thatcher Memorial Fountain, Denver, Col.; 'Alma Mater' for University of Illinois.

TAFT, William Howard, 27th President of the United States: b. Mount Auburn, Cincinnati, 15 Sept. 1857, son of Judge Alphonso (q.v.) and Louisa M. (Torrey) Taft. After graduating with honors from Yale (1878) he studied law in Cincinnati, being admitted to the bar in 1880. From 1881 to 1883 he was assistant prosecuting attorney in Hamilton County, Ohio, and for a time Collector of Federal Internal Revenue. From 1883 to 1887 he practised law in Cincinnati, after 1885 being assistant county solicitor. In 1886 he married Miss Helen Herron. In 1887 Governor Foraker appointed him to fill an unexpired term as judge of the Superior Court. He was later elected for a full term; but in 1890 he was appointed solicitor-general of the United States by President Harrison. In 1892 he was made a Federal judge of the sixth circuit, a position for which by temperament and training he was admirably fitted, and the work of which he found most congenial.

On 12 March 1900 President McKinley chose him to head a commission to establish civil government in the Philippines, and on 4 July 1901 he became first civil governor. Taft accepted both appointments at the expense of his personal preference for a career on the bench, being influenced by a deep sense of responsibility toward and a genuine affection for the Filipinos. In 1902 Roosevelt twice offered him an appointment to the Supreme Bench of the United States, but he put aside what has been his chief personal ambition because he felt his immediate duty was to continue in the islands. As an executive his work was highly successful. In 1902 he conducted at Rome the important negotiations for the purchase of the Catholic Friars' lands. To a remarkable degree he won the confidence and affection of the Filipinos, though he disappointed many by his frank statement that in his judgment it might be two

WILLIAM HOWARD TAFT

Twenty-seventh President of the United States

generations before they would be ready for complete self-government. He believed in «The Philippines for the Filipinos,» and opposed exploitation primarily in the interest of American capital. He urged tariff concessions for Philippine products.

On 1 Feb. 1904 he became Roosevelt's Secretary of War, and for over four years was engaged in such important enterprises as the building of the Panama Canal. In 1906, when disorders called for American intervention, he was sent to Cuba, and for a time acted as provisional governor. In 1907 he visited Cuba and Panama, and later Japan and China, going to the Philippines for the opening of the legislative assembly, and returning by way of Russia. In 1906–13 he acted as president of the reorganized American Red Cross.

By 1907 Roosevelt was exerting his influence to secure the Republican nomination for his Secretary of War, whom he described as possessing «a standard of absolutely unflinching rectitude on every point of public duty, and a literally dauntless courage and willingness to bear responsibility,» besides a knowledge of men, tact and kindliness. Nominated on the first ballot, June 1908, Taft resigned as Secretary. The campaign with Bryan was fought largely on the issue of continuing the «Roosevelt policies,» the President declaring that Taft was «the man who I feel is in an especial sense the representative of all that in which I most believe in political life.» With this recommendation, and on the strength of his ideal training for the office, Taft was given 321 electoral votes to Bryan's 162.

As President he lacked the magnetism and dramatic force of his predecessor. In general he took a moderate position on public questions. «We middle-of-the-road people,» he said (1911), «who are not extremists are, we believe, the real Progressives, because you do not make progress by great strides; you make progress step by step.» His position on important issues may be summarized as follows: (1) In connection with the Payne-Aldrich Tariff Bill he used his influence in favor of downward revision to a protective basis, just sufficient to cover the difference in cost of production between here and abroad. Though not satisfied with some provisions, he signed and defended the law as the best ever passed. He favored further revision on the basis of reports to be made by a tariff commission; and he vetoed later revisions of several schedules largely because they were not based on such reports. He worked for reciprocity with Canada. (2) On conservation his fundamental views were not so different from those of the Progressives as they seemed to believe. He hesitated, however, to stretch the executive power, and Congress was slow to give him the power he requested. Unfortunately his support of Secretary Ballinger against Roosevelt's friend, Pinchot, appeared to place him in opposition to the policies of his predecessor. (3) In the matter of railroad and trust regulation he favored strict enforcement of existing law and his administration secured the dissolution of the Standard Oil and Tobacco trusts. He urged the clarification of the Sherman law and favored Federal charters for corporations doing interstate business. (4) He was opposed to the more radical schemes of direct popular government, in particular the «recall of judicial decisions.» (5) He favored and extended civil service reform, worked for efficiency and economy in government, especially urging a budget system and advocating pensions for Federal employees. (6) In foreign affairs he worked heartily for peace, negotiating treaties for arbitration and the judicial settlement of international difficulties, which were rejected by the Senate. By «dollar diplomacy» the administration sought to secure opportunities for trade and the investment of capital. This policy was denounced by some as leading to imperialistic interference in the affairs of weaker nations, and making government diplomacy a mere agent of big business.

Some of these views were too progressive to suit the old leaders, and yet it was not long before the insurgent Progressive-Republicans were denouncing the President as too friendly with reactionary party bosses and big business, and a deserter from progressive standards. Believing in the necessity of party government, the President did feel it necessary to work with and through the party majority in Congress. For a time he withheld patronage from insurgent senators and representatives, and when he changed his policy the damage had been done. The defense of the Tariff Bill, the dismissal of Pinchot, the repeated vetoes of later tariff reduction bills, the veto of the grant of statehood to New Mexico and Arizona because of radical provisions in their constitutions, all increased his unpopularity. The elections of 1910 gave the Democrats a majority in the House and showed a popular discontent with the old Republican rule and a drift toward Progressive Republicanism or toward the Democratic party. In Congress the insurgent Republicans often joined the Democrats to defeat the regular Republicans. In 1910 Roosevelt returned from Africa, and before long was openly taking issue with the policies of his successor. By 1911 the Progressive Republicans were planning to prevent the renomination of Taft. At first La Follette was to be their candidate, then they turned to Roosevelt. Early in 1912 he agreed to accept the nomination. In the States having direct primaries Roosevelt made a much better showing than Taft; but the control of the party machinery by the regulars brought about the President's renomination. The Progressives started a new party, ensuring the overwhelming defeat of the President in November and the election of Wilson.

The outstanding feature of the administration was the conflict between conservative and progressive forces; but the confusion and recrimination should not obscure important developments during these four years. Among these were the reform of the rules of the House of Representatives (1910); the corporation tax (1909); increased powers of the Interstate Commerce Commission; Postal Savings Bank (1910) and Parcel Post (1912); Children's Bureau (1912) and Department of Labor (1913); publicity for and limitation of campaign contributions (1910–11); submission of amendments on income tax and direct election of senators.

Since 1913 Mr. Taft has been Kent professor of law at Yale University, lecturing on constitutional law in the college and the law school. He has continued to take an active interest in promoting international peace and a League of Nations. During the World War he was joint chairman of the National War Labor Conference Board.

With the calming of factional bitterness, Mr. Taft has gained again in the public esteem and confidence, and the accomplishments as well as the mistakes and difficulties of his administration appear in a better perspective.

ARTHUR P. SCOTT,
Assistant Professor of History, The University of Chicago.

TAGABAWAS, tä-gä-bä'väs, a Philippine people living on both sides of Dávao Bay, Mindanao, a mixture of several Malay tribes.

TAGACAOLOS, tä-gä-kä'ō-lōs, a Philippine tribe, whose settlements are scattered among other tribes along Dávao Bay, Mindanao.

TAGALS, tä-gäls', **TAGALOGS**, or **TAGALOS**, a Philippine people of Malay origin, inhabiting chiefly Manila, the provinces of Cavite, Bataán, Bulacán, Batangas, Infanta, Laguna, and Mindoro, and scattered among other tribes in several other provinces. They are Christians and one of the leading peoples of the archipelago, both in numbers and in culture; they possessed an alphabet and considerable civilization before the arrival of the Spaniards. They were the leading element in the last insurrection against Spain, and proved troublesome after American occupation. They are, however, intelligent, shrewd and generally industrious; and when once comprehending American ideals prove trustworthy. See PHILIPPINE ISLANDS.

TAGANROG, tä-gän-rŏg', Russia, a town in the government of Ekaterinoslav, on a lofty promontory on the Sea of Azov, opposite the mouth of the Don, 28 miles west-northwest of Azov. There is a monument to Alexander I, who died here; also churches, exchange, gymnasia, etc. It has manufactures of candles, leather, tobacco, macaroni, etc. The harbor, though the deepest in the Sea of Azov, is shallow, not admitting vessels which draw more than 10 feet; but its situation secures to it a considerable trade. The principal exports are wheat, rye, barley, oats, linseed, rapeseed, wool, oil-cake, caviar and butter; the imports include fruit, oil, machinery, hides, petroleum, dry goods, wine, etc. The annual exports previous to the World War averaged over $50,000,000. Pop. 71,000.

TAGBANUAS, tąg-bä'noo-as, native tribes of the Philippine Islands inhabiting the island of Palawan. They may be classified into five groups, some more civilized than others, according to the nature of the locality and the extent of contact with the coast tribes. The Tagbanuas Apurahuanos have a peculiar writing and alphabet. They have an elaborate system of government, laws for the regulation of morals and feast days. Their god is Diwata, whose principal officer and representative on this earth is called the Babailan, who may be of either sex. Consult Venturello, M. H., 'Manners and Customs of the Tagbanuas and Other Tribes of the Island of Palawan, Philippines' (in 'Smithsonian Miscellaneous Collections,' Vol. XLVIII, p. 514 et seq., Washington 1907).

TAGBILARAN, täg-bē-lä'rän, Philippines, pueblo, capital of the province of Bohol; on the southwest coast. Opposite the town is the important dependent island of Panglao, separated from Bohol Island by a strait one mile in width. The chief industries are agriculture and turtle fishing. Pop. 11,000.

TAGES, tä'gĕz, in early Italian mythology, son of a minor local deity, or genius, and grandson of Jupiter. He taught the Etruscans the arts of augury and divination, and was said to have sprung forth from a clod of earth freshly turned up by a husbandman named Tarchon, in the neighborhool of Tarquinii.

TAGGART, Marion Ames, American writer for young people: b. Haverhill, Mass., 7 May 1866. She has published 'The Blissylvania Post Office' (1897); 'Aser, the Shepherd' (1899); 'The Wyndham Girls' (1902); 'In the Days of King Hal' (1902); 'Nut-Brown Joan' (1904); 'Pussy Cat Town' (1906); 'Betty Gaston' (1910); 'Nancy the Doctor's Little Partner' (1911).

TAGGART, Thomas, American congressman: b. County Monyhan, Ireland, 17 Nov. 1856. He came to the United States in 1861 and settled at Xenia, Ohio. He engaged in the hotel business at Indianapolis in 1877, and since 1886 has been active in politics. He was chairman of the Democratic State Committee in 1892–94; mayor of Indianapolis in 1895–1901; and in 1916 was appointed to fill the vacancy in Congress caused by the death of B. J. Snively. He was elected to Congress in 1912 and in 1914.

TAGISH, a tribe of American Indians formerly residing about the headwaters of Lewis River, Alaska. A remnant of the tribe still exists.

TAGLIONI, täl-yō'nē, **Maria**, Italian ballet dancer: b. Stockholm, Sweden, 23 April or 18 March 1804; d. Marseilles, France, 23 April 1884. Her father was Philippo Taglioni (b. Milan, 1777; d. 1871), a ballet master at different opera-houses successively in Europe. She was rigorously trained by her father and developed a marvelous grace, so that she became the admiration of Europe in her day. She made her début at Vienna in 1822; appeared at Paris in 1827, and at Berlin, London and other capitals later. Her style was termed «ideal»; was chaste and refined in distinction to the «realistic» dancing of her predecessors, Gardel and Vestris. Her great successes were 'La Bayadire,' 'La Sylphide,' composed for her by her father, and 'La Fille du Danube.' In 1832 she was married to Count Gilbert de Voisins, and in 1847 retired from the stage. She is frequently mentioned in contemporary literature, particularly by Balzac and Thackeray.

TAGORE, tą-gôr, SIR **Rabindranath**, Hindu poet: b. Calcutta, 1861. His father Maharshi Devendranath Tagore was a famous spiritual leader who belonged to a family distinguished for many generations throughout India. He was educated chiefly under private tutors and at the age of 17 visited England. By this time he was writing verse, largely imitative of the old Vaishnava poets. When he was 18 years old he published 'Sandhya-Sangita' ('Songs of Sunset'), and 'Pravata-Sangita' ('Songs of Sunrise'). In these he arises to the height of neo-romanticism in Bengali poetry. In 1884 he was married and went to

Shilaida on the banks of the Ganges to manage his father's estate. There he came into touch with the real life of the people and wrote poems, tales, parables and dramas dealing with their everyday affairs. His best known works of this period perhaps are 'The Crescent Moon,' 'The Gardener,' 'Gitanjali' and 'The Hungry Stones and Other Stories.' This second or Shilaida period of his life, which lasted 17 years, had a sad ending, as he lost in rapid succession by death, his wife, daughter and the younger of his two sons. At the age of 40 in 1901 he began work at Bolpur, which centred around his school, 'Shanti Niketan,' or translated, 'Abode of Peace.' Beginning with two or three boys it had grown in four years to 60, and in 1919 numbered over 200 boys. This school, while strictly Indian in its characteristics, embodied in itself, in forms modified to environmental conditions, the most advanced educational ideas of the world to-day, while retaining also the best traditions of the ancient Indian garden and forest schools. It is interesting to Americans to note that the self-government of his school is largely modeled after that of the George Junior Republic. Here Tagore brought the power of his personality to play upon an increasing number of young men who are making the India of to-morrow. The award of the Nobel prize in literature in 1913 brought him into world fame, and in 1915 he received the honor of knighthood. He has published in Bengali over 30 poetical works and 28 prose works, including novels, short stories, essays, sermons, dramas, etc. With a fine appreciation of the value of the English language he has made his own translations and published in English 'Chitra' a play; 'The Crescent Moon: Child-Poems'; 'The Gardener'; 'Gitanjali'; 'Personality'; 'The King of the Dark Chamber'; 'Reminiscences'; 'Songs of Kabir'; 'Sadhana: the Realization of Life'; 'The Hungry Stones and Other Stories'; 'The Post Office'; 'Fruit Gathering'; 'Stray Birds'; 'The Cycle of Spring'; 'Sacrifice and Other Plays'; 'Nationalism'; 'Mashi and Other Stories'; 'Lover's Gift and Crossing.' Consult Rhys, E., 'Rabindranath Tagore' (1914); Pearson, W. W., 'Shantiniketan: The Bolpur School' (1916); Roy, B. K., 'Rabindranath Tagore: The Man and His Poetry' (1916).

TAGUS, tā'gŭs (Spanish, *Tajo*; Portuguese, *Tejo*), the largest river of Spain and Portugal, rising in the mountains of Albarracin, on the frontier of New Castile and Aragon, a little more than 100 miles from the Mediterranean. Pursuing first a northwesterly and then a southwesterly course, it passes by Aranjuez (a little south of Madrid), Toledo, Talavera and Alcantara, enters Portugal, and passes by Abrantes, Santarem, below which it begins to broaden into its fiord-like and expanding estuary, contracting again below Lisbon, and 10 miles farther down flowing into the Atlantic. Total length, 565 miles. The tide reaches nearly to Santarem, and regular navigation of the river begins at Abrantes. It flows through a mountainous country and its current is much broken by rocks and cataracts. Its principal affluents are the Jarama, Guadarrama, Alberche, Tietar, Alagon, Elja and Zezere on the right bank; and the Guadiela, Almonte, Salor, Sever and Sorraia on the left.

TAHITI, tä-hē'tē, formerly **OTAHEITE**, the largest of the Society Islands, situated in the southern Pacific Ocean, in lat. 17° 40' S., and long. 149° 30' W. It consists of two mountainous, volcanic and roughly circular parts, united by a low, narrow neck of land, and abounds in magnificent scenery. The greatest dimension is northwest and southeast, 28 miles; the total area is about 400 square miles, and the highest point 7,320 feet above sea-level. The climate is very agreeable. The natural vegetation is extremely beautiful and luxuriant, but cultivation is limited to the coastal plain, where also nearly all the population is located. Copra, pearl-shell, cotton, vanilla and oranges are the chief exports, whose value in 1902 amounted to $860,000. Papeete, on the northwest coast, is the French administrative capital for all the French possessions in Polynesia. The native Tahitians were once a splendid race, noted for their simple, idyllic life. (See TAHITIAN LITERATURE). The vices introduced by contact with civilization soon brought about moral and physical degeneration, and the native inhabitants are rapidly diminishing in number. The island was discovered by a Spanish navigator, Quiros, in 1605, and visited by Captain Cook in 1769. In 1842 it came, as a native kingdom, under French protection, and in 1880 was declared a French colony. Pop. about 12,000. See SOCIETY ISLANDS.

TAHITIAN (tä-hē'tĭ-an) **LITERATURE.** As mentioned under Tahiti, the natives of this southern Pacific island were once a beautiful race, living a natural, simple and idyllic life, as expressed in the accounts of Tahiti by Wallis, Bougainville, Cook and others, and idealized in the works of Melville, 'Omoo' (The Rover); Stoddard, 'Idylls'; and Loti, 'Marriage.' Notwithstanding their physical and moral degeneration since the introduction of European civilization, the evidences of the aboriginal state of existence, outside the recitals of early explorers, are to be found in their traditions and legends preserved in the native songs and poems of the existing Teva family, of royal lineage, descended from Hototu, first queen of Vaieri, who married Temanutunu, the first king of Punauia. The songs, generally of love, war and lamentation, locally called *himenes*, are sung as a kind of choral chant with a monotonic buzzing bass, on which a high shrill cadencing is repeated indefinitely, ending always in a long iee-i-é-e. The longer poems recite the history of the family, the various forms of etiquette and addresses for visits; shorter poems consist of soliloquies, laments, reproofs and ceremonial topics. Among favorites of which English translations have been made are the 'Coronation Song of Pomare'; 'Lament of Aromaiterai': 'Soliloquy of Teura, a beauty asked to wed Punu, an old chief'; and 'Song of Reproof, at the beginning of the Wars between Teva and Purionu, in 1768.' Consult La Farge, 'Tahitian Literature' (p. 14389, Vol. XXIV); 'Warner's Library of the World's Best Literature.'

TAHLEQUAH, tä-lē-kwä', Okla., town, former capital of the Cherokee Nation, in the valley of the Illinois River, about 18 miles east of Port Gibson, and 25 miles northeast of Muskogee, on the Saint Louis and San Francisco Railroad. It is in a fertile agricultural region. It contains two public high schools, the Cherokee National Female Seminary and the Cherokee National Male Seminary. The latter was founded in 1847. There are two mission schools, the Baptist and the Presbyterian, and two school libraries. There is one bank and four weekly newspapers. The manufacturing is increasing, and there are grain elevators, cotton gins and flour mills. Pop. (est.) 3,000.

TAHOE, tä-hō', a lake at the base of the Sierra Nevada, on the boundary between California and Nevada, part in Placer County, Cal., and part in the counties of Douglas and Ormsby, Nev. It is about 20 miles long and from 8 to 12 miles wide, and has an altitude of 6,275 feet, and an extreme depth of 1,650 feet. The outlet is Truckee River. Lake Tahoe is noted for its beauty and the picturesque surroundings. It is a favorite and unique summer resort, on account of the cool and healthful climate and the beautiful scenery.

TAHPANHES, or **TEHAPHNEHES,** an ancient city of Egypt, mentioned in the Bible (Jer. ii, 16; xliii, 7), usually identified with the Daphnæ of the Greeks, situated in the northeastern part of the Delta, about 30 miles southwest of Pelusium. In 1886 the site was explored by Petrie (q.v.), who gives an account of the work in his 'Tanis,' Part II (1887).

TAHR, tär, a wild goat (*Hemitragus jemlaicus*), found on steep tree-covered slopes along the whole range of the Himalayas from Kashmir to Bhutan. The horns are about a foot long, flattened, with a notched anterior margin; body fawn-brown; the hair of the neck, chest and shoulders hangs to the knees; the female is lighter in color with smaller horns. Its nearest relative is the nilghiri goat of central India.

TAI-CHU, tī'chow', the former capital of Formosa (q.v.). See Tainan.

TAI-NGNAN-FU, tī'ngän'foo', China, a city in the province of Shantung, situated 35 miles southeast of Tsi-nan, on the railway to Yichau. It has a temple covering a large area, which draws many pilgrims bound for Mount Tai, which is regarded as sacred. Pop. about 75,000.

TAI-TOU, empress of Abyssinia: b. 1853; d. Addis Abeba, 11 Feb. 1918. She was a daughter of the king of Gondar and took an active part in the troublous politics of Abyssinia, and was concerned in all the civil wars and intrigues which ended in the raising of Menelik, whom she had taken for her fifth husband in 1883 when he was simply king of Shoa, to the position of Negus-Negusti (emperor) in 1889. At Adowa where the Italians suffered a crushing reverse, she accompanied Menelik to battle headquarters and put her own hereditary troops in the field. During Menelik's long illness she practically governed the country and kept it from internal disorders. On Menelik's death in December 1913, his grandson, Lidj Jeassu, a youth of 18 and no blood relation of the empress, became emperor, but failed to maintain order, and largely on Tai-Tou's initiative he was deposed in September 1916, and his aunt, Zauditu, Menelik's older daughter, was proclaimed empress.

TAI-YUAN-FU, tī'wän'foo', China, the capital of the province of Shan-si, situated near the centre of the province, 260 miles south of Peking. It consists of a Chinese and a Tatar city separated by a high wall. The city has served as the residence of the emperors and contains a number of magnificent mausoleums. The surrounding region is very fertile and contains rich coal deposits. Pop. over 200,000.

TAIHOKU, Formosa, capital of the island. It has progressed rapidly since it came under Japanese government in 1898. Systematic colonization was begun in 1909, and in 1916 the population was over 100,000. See Formosa.

TAILFER, Patrick, American colonist: lived in the 18th century. He was a physician and emigrated to the newly-founded colony of Georgia in 1740. Later he removed to Charleston, S. C. He is remembered for his joint authorship of 'A True and Historical Narrative of the Colony of Georgia from the First Settlement thereof Until the Present Time' (1741). It is a severe arraignment of Gen. James Oglethorpe's method of governing the colony and accuses the general of undue exercise of arbitrary authority and of putting his personal interests before those of the settlers. The work has been the subject of much discussion as to whether it was justified or was merely the expression of a group of malcontents.

TAILLON, Sir Louis Olivier, Canadian statesman: b. Terrebonne, Quebec, 26 Sept. 1840. He was educated at Masson College and was called to the bar in 1865. He engaged in practice at Quebec in 1882 and became one of the leaders of the bar. He served in the Quebec assembly from 1875; was speaker in 1882–84; Attorney-General in 1884–87; and in January 1887 he formed an administration, but resigned in two days and until 1890 was leader of the Opposition. He was appointed Minister without Portfolio in December 1891; was Prime Minister in 1892–96; and Postmaster-General in 1911. He was knighted in 1916 some years after his retirement to private life.

TAILOR-BIRD, an East Indian warbler (*Orthotomus* or *Sutoria sutoria*), one of many species in a large genus which exhibit a close similarity in structure and habits. They inhabit cultivated districts, are dressed in plain tints, feed chiefly on insects, and are peculiar mainly in their nest-making. They either sew a dead leaf to a living one or join two neighboring leaves together, so as to form a kind of hanging pouch, which remains attached to the branch by the leaf-stalk of one or both leaves. The threads which they use consist generally of twisted vegetable fibres or of actual cotton threads, the bill serving for a needle in puncturing holes in the leaves and in drawing the threads through. Occasionally, if a large enough leaf be found, the nest may be formed by joining together the free edges of the leaf. The lower part of the pouch contains the nest, which is a cup of soft materials and is entered from above. The actual structure of this ingenious cradle has never been scientifically observed, although tailor-birds are common. The best information is contained in Hume, 'Nests and Eggs of Indian Birds' (London 1890).

TÁIN BÓ CÚALNGE, THE CUALNGE CATTLE-RAID. The mediæval Irish scholars catalogued their native literature under several heads, to one of which they gave the name Táin, by which they meant a "reaving" or a "driving" of cattle. The most important tale belonging to this class is the subject of this article. The professional Irish story-tellers also arranged their epic tales according to cycles, one of which was known as the Ulster cycle, because the scene is always laid in Ulster; as the cycle of Conchobar (Connor), the king round whom the Ulster warriors mustered; as the Red Branch cycle, from the name of their banqueting hall; and, finally, as the Cuchulainn cycle, from the name of the champion round whom the saga pivots. The 'Táin Bó Cúalnge' has always enjoyed the reputation of being the most celebrated story of Irish antiquity.

The following is the argument of the Cualnge Cattle-Raid: One night a dispute arose between Queen Medb of Connaught and her husband, Ailill, as to the amount of their respective possessions. On matching their wealth, they were found to be equal, except that among the king's herds was a lordly bull called "the Whitehorned." Thereupon Medb dispatched her courier to Daré mac Fiachna, a rich landowner in Cualnge (Anglicé Cooley), in Ulster, to ask for the loan of his wonderful bull, called "the Brown of Cualnge." Daré at first granted the queen's request but, incensed at a remark made by one of the envoys, he withdrew his promise and swore that never would he hand over the Brown Bull of Cualnge.

Medb straightway gathered a formidable army composed of allies from all parts of Ireland wherewith to undertake the invasion of Ulster and to carry off Daré's bull by force.

Now it happened that the expedition took place while the Ulstermen suffered a debility which lasted all winter and the burden of defending the province fell on the shoulders of a stripling of 17 years of age, namely Cuchulainn, who was exempt from the curse which had befallen the remainder of the champions of Ulster.

Cuchulainn confronted the foe and agreed to allow them to continue their march on condition that every day they send one of their champions to meet him in single battle. When he shall have killed his opponent, the host shall halt and pitch camp until the following morning. Queen Medb agrees to abide by those terms. In each of the combats which ensue, the heroic youth is victorious and slays many of the most celebrated warriors on the side of Connaught. The severest of all those single fights was the one which lasted four days and in which he had as antagonist his early friend and foster-brother, Ferdiad. After the death of Ferdiad, Queen Medb, impatient at these delays, broke the sacred laws of ancient Irish warfare and overran Ulster with fire and sword.

By this time the Ulstermen have come out of their debility and gathered their forces. In the final battle Medb's army is repulsed and retreats in flight into Connaught. But she had the satisfaction of carrying off with her the prize and the cause of the war, the Brown Bull of Cualnge.

The events which the 'Táin Bó Cúalnge' relates and its personages are ascribed by the Irish annalists to about the time of the birth of Christ, that is to about 300 years before the introduction of Christianity into the island, and such has been the constant Irish tradition. It belongs to a period when agriculture was almost unknown, when land was plenty and when the possession of kine to place upon it was of first importance and when cattle-raids were of frequent occurrence. The general condition of culture described in the saga corresponds in a remarkable way with the earlier part of the age to which archæologists have given the name La Tène, or Late Celtic, and which terminated at the first century of our era.

The 'Táin Bó Cúalnge' even carries us back to one of the earliest and most widespread beliefs of the great linguistic family to which we belong, to one of the most primitive aspects of a world-wide nature-myth. Its great protagonist, Cuchulainn, gives us the impression of a god, who appears to personify warmth and light struggling against the powers of cold and darkness. In the earliest version of the story, he is the son of the supreme god Lug and a mortal woman. Hence the curious combination that we find in him: On the one hand he acts like a brave and courtly warrior; on the other, his supernatural exploits exceed the course of ordinary human existence. By the time the tale had been given an historical framework and had been consigned to writing, the mythological idea from which it had sprung was, at most, but dim and uncertain. The story-tellers and their hearers regarded Cuchulainn and the other characters of the saga as real Irish men and women, and, although we are not to look for historical accuracy in the saga in every particular, it is very likely that, in the main, the events narrated really took place and the protagonists really existed.

The whole spirit of the 'Táin Bó Cúalnge' is strongly pagan, which is another proof that the tale was committed to writing very early in the Christian period. It is not the work of any one man, but the epic of all Ireland, the accumulated work of generations, the last stage of a slow evolution. Its arrangement in literary form may have taken place as early as the 5th century and its shaping, substantially as we have it, dates from the first half of the 7th century, if not earlier. The earliest manuscripts containing it probably disappeared during the Viking invasions, with the result that the oldest extant version dates from the year 1100. From that date till the middle of the last century a score or more of manuscripts have preserved it. Consequently, the 'Táin Bó Cúalnge' is the most ancient epic tale of western Europe and its composition antedates by a wide margin the epic tales of the Anglo-Saxons, the Scandinavians, the Franks and the Germans. Furthermore, it is entirely original and contains not the slightest hint of any foreign derivation.

The 'Táin Bó Cúalnge' is in prose interspersed here and there with verse and is not a work of art like the 'Iliad' or the 'Odyssey'; it is not a finished epic, but an epic in the making, showing better perhaps than any other work in literature the development of popular tradition through more than a thousand years and the earlier stages of an epic. It affords a picture of an old barbaric civilization, with all its inherent imperfections and roughness, wild phantasy and extravagance of deed and description, as it arose and developed among the people, unvarnished by poetic art. Withal it evinces poetic worth and contains some passages which are not surpassed in any literature.

The 'Táin Bó Cúalnge' is a great tale, one of the greatest and most curious in the world, and of the utmost importance to the philologist, the folklorist, the archæologist and the historian. For the first time in Europe it brings to light a high and romantic chivalry. It is a tale that is worthy of any literature in the world and no other race with which the Celts may be compared is able to produce any such ancient indigenous literary monument.

Bibliography.— The text of the Táin, from the most important manuscripts, has been published by Ernst Windisch, 'Die Altirische Heldensage, Táin Bó Cúalnge,' Irische Texte, Extraband (Leipzig 1905), which contains complete apparatus, introduction, notes and vocabulary; Faraday, L. W., 'The Cattle-Raid of Cualnge' (London 1904) is a translation based on one manuscript; Hull, E., 'The Cuchullin Saga' (London 1898; contains a translation by Standish H. O'Grady); Hutton, M. A., 'The Táin, An Irish Epic Told in English Verse' (Dublin 1907) is a paraphrase, as is Gregory, Lady A., 'Cuchulain of Muirthemne' (London 1903); Dunn, J., 'The Ancient Irish Epic Tale, Táin Bó Cúalnge, The Cualnge Cattle-Raid' (London 1914) is the first complete version in English and (pages xxxii–xxxvi) contains a full bibliography on the subject.

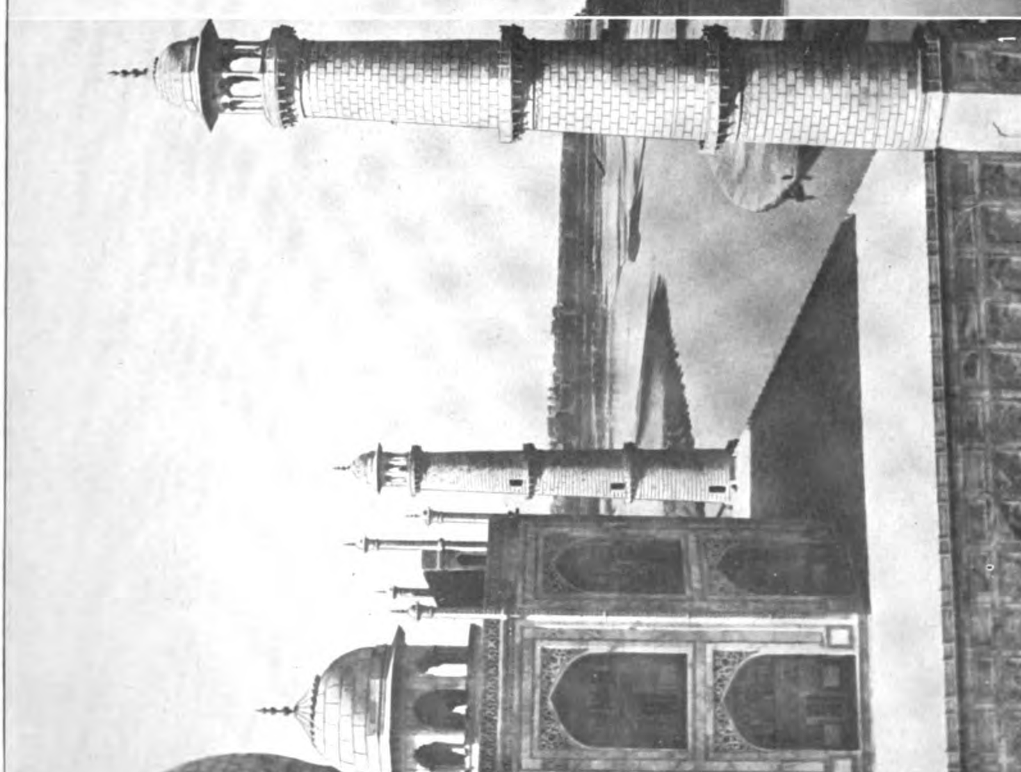
JOSEPH DUNN,
Professor of Celtic Languages and Literatures, The Catholic University of America.

TAINAN, tī'nän', Formosa, Japan, a city situated on a small river near the southwest coast of the island. Until 1896 it was the capital of the island. A canal connects it with Formosa Channel. Under the Chinese and Japanese régimes it has had the status of a treaty port. There are a rice mill and several sugar mills. Pop. 53,790.

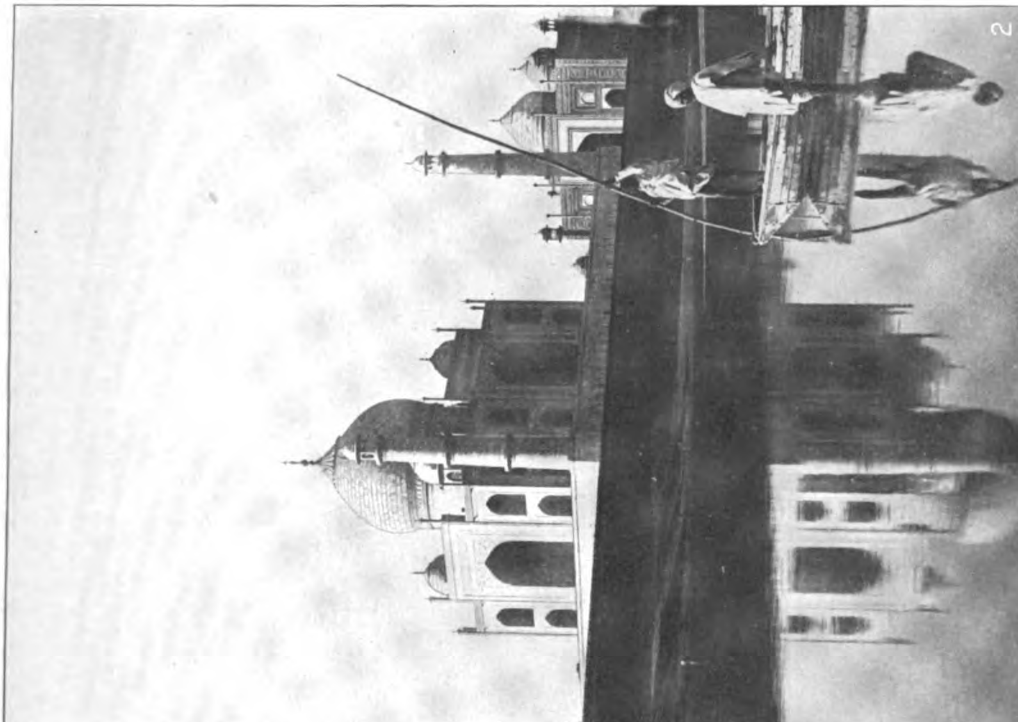
TAINE, tān, **Hippolyte Adolphe,** French critic and historian: b. Vouziers, Ardennes, 21 April 1828; d. Paris, 5 March 1893. He was educated at the Collège Bourbon and the Ecole Normale, Paris, was assigned by the government, which thought his talent dangerous, to a provincial post as instructor, but resigned this and devoted himself to literature, writing in quick succession 'Essai sur La Fontaine' (1853; rev. ed. 1860), 'Essai sur Tite Live' (1854) and 'Philosophes Français du XIXe Siècle' (1856). In 1864 he was appointed to a professorship in the Ecole des Beaux-Arts, where his series of lectures on the history of art were patterns of philosophical criticism. The dissolution of the empire and the attendant troubles directed him to the study of the philosophy of history and in connection therewith he wrote his 'Origines de la France contemporaine' ('Ancien Régime,' 1876, 'Revolution,' 1878–84, 'Régime Moderne,' 1890 — unfinished), a work of great erudition, in which he condemns the royalists, but finds their gravest faults repeated by the republicans and makes his bitterest attack on Napoleon. Thus he alienated all parties, holding all responsible for the disasters of the "Terrible Year." A work more familiar to readers in the United States and England is his 'Histoire de la littérature anglaise' (1864; Eng. trans., by Van Laun). The brilliancy of this performance is unquestioned, but the justice of its method has been much discussed and while Taine became the founder of a cult in France, he found in England and America no imitators of importance. Literary criticism, æsthetics and psychology were to him sciences as exact as chemistry; he treated them with a laboratory style of analysis and deduction. "Little facts, well-chosen, important, significant, amply substantiated, minutely noted" — such, in his own words, he made his material. "The whole world," said Bourget, "seemed to Taine matter for intellectual exploitation." Taine judged all products of the human mind by the three inflexible standards of race, epoch and surroundings and these he manipulated as if they were mathematical formulæ. He quite disregarded the factor of individuality and reduced everything to that rigorous systematization which drew protest from Amiel. He succeeded in pointing out certain things which no other historian had noted, but dogmatized to a degree no longer regarded as permissible. (See ORIGINS OF CONTEMPORARY FRANCE). Taine's other published works include 'Essais de critique et d'histoire' (1857); 'Ecrivains actuels de l'Angleterre' (1863); 'Idéalisme anglais' (1864), a study of Carlyle; 'Positivisme anglais' (1864), a study of John Stuart Mill; 'Nouveaux essais de critique et d'histoire' (1865); 'Philosophie de l'art' (1865); 'Philosophie de l'art en Italie' (1866); 'Voyage en Italie' (1866); 'Notes sur Paris, ou vie et opinions de M. Frédéric-Thomas Graindorge' (1867); 'L'Ideal dans l'art' (1867), lectures delivered at the Ecole des Beaux-Arts; 'Philosophie de l'art dans les Pays-Bas' (1868); 'Philosophie de l'art en Grèce' (1870); 'Du suffrage universel' (1871); 'Notes sur l'Angleterre' (1871), a work of considerable value; 'Derniers essais de critique et d'histoire' (1894) and 'Carnets de voyage: notes sur la Province' (1897). Taine was created honorary D.C.L. of Oxford in 1871 and in 1878 he was elected a member of the French Academy. Consult Monod, 'Les maitres de l'histoire' (1894); Lemaitre, 'Les contemporains'; De Margerie, 'H. Taine' (1894); Boutmy, M. E., 'Taine, Scherer, Laboulaye' (Paris 1901); Giraud, V., 'Hippolyte Taine' (ib. 1901); Aulard, A., 'Taine, historien de la Revolution française' (Paris 1907); Gummere, F. B., 'Democracy and Poetry' (Boston 1911).

TAINTER, Charles Sumner, American inventor: b. Watertown, Mass., 25 April 1854. He has invented the graphophone and was the associate inventor of the radiophone. In 1874 he was a member of the United States expedition sent to the South Pacific to observe the transit of Venus. In 1881 he received the gold medal at the Electrical Exhibition, Paris, for his inventions in connection with the radiophone and in 1889 was given the French Academy decoration, 'Officier de l'Instruction Publique' for the invention of the graphophone; in 1900 he received the John Scott medal in Philadelphia for this same invention.

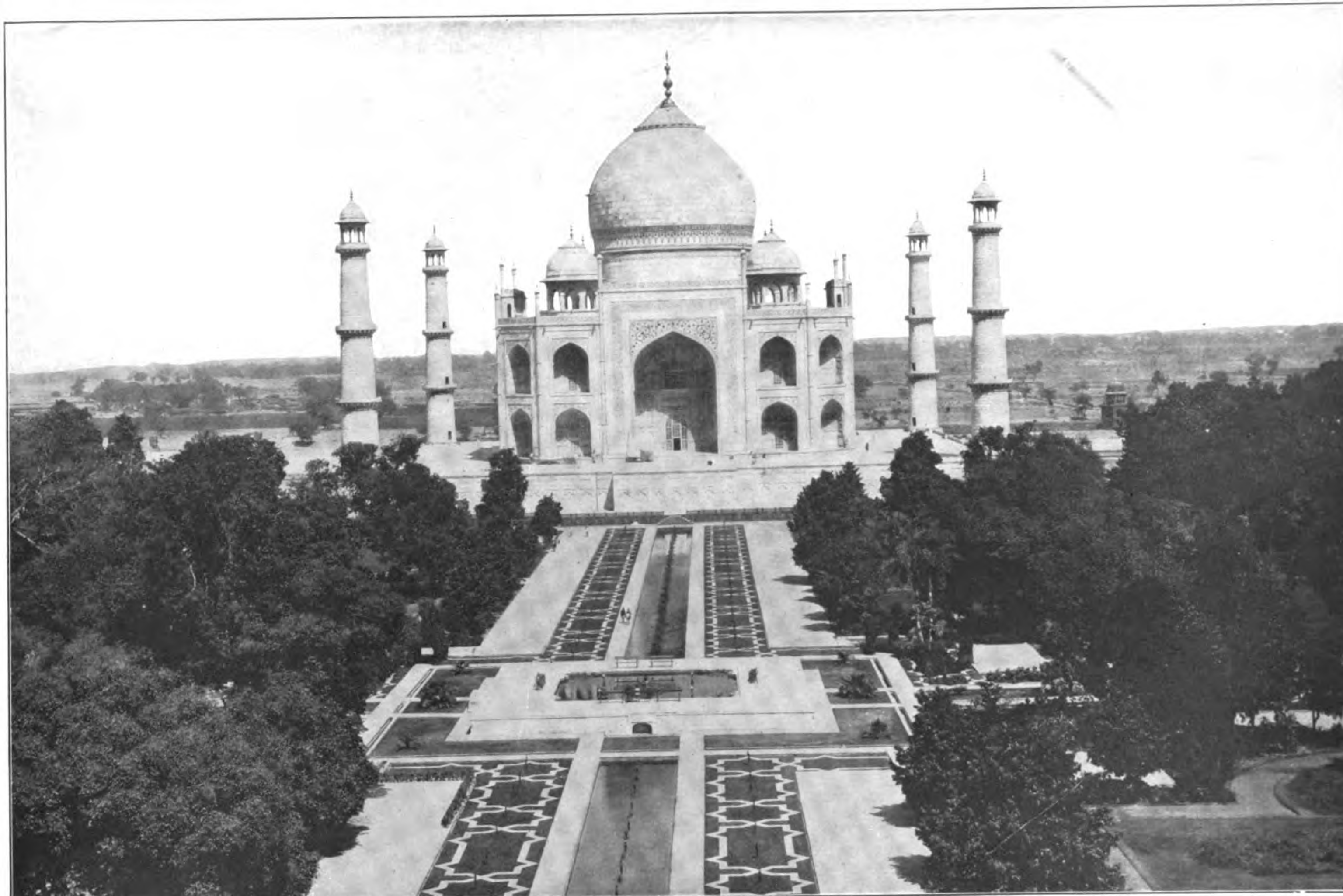
TAIPINGS, tī'pĭngs', the name given by foreigners to the insurgent followers of Hung



1 View from the Taj Mahal up the Jumna River to Agra



2 The Taj Mahal (built 1629-51), Tomb of Mumtaz Mahal, favorite wife of Shah Jehan



THE TAJ MAHAL

Hsiû-ch'wan, who raised a formidable rebellion in China in 1851 and who until his suppression in 1864, was looked upon by his disciples as emperor of the dynasty of Taiping — signifying Grand Peace, and the T'ien Wank — Heavenly King, of the T'ien Kwo — Kingdom of Heaven.

TAIT, tāt, **Archibald Campbell,** English prelate, archbishop of Canterbury: b. Edinburgh, 21 Dec. 1811; d. Addington, 1 Dec. 1882. Brought up a Presbyterian, he received his education in the schools of his native city. He entered the University of Glasgow in 1827, and having gained a Snell exhibition he matriculated at Balliol College, Oxford, in 1830, becoming about the same time a member of the Church of England. He was graduated with a first in classics in 1833, elected a Fellow of his college in the following year, ordained in 1836, and was active as tutor of Balliol for seven years. While several of his intimate friends joined the Tractarian movement, he himself kept aloof from it, and joined in the protest against Tract XC. He succeeded Dr. Arnold in the headmastership of Rugby School in 1842, and retained this post till 1850, when he was appointed dean of Carlisle. He took an active part in the work of university reform at Oxford, and in 1856 he was appointed to the see of London. He declined the archbishopric of York in 1862, and in 1869 was appointed archbishop of Canterbury. He at first opposed the bill for the disestablishment of the Irish Church, but on being appealed to personally by the Queen he accepted the inevitable. He was also instrumental in securing the enactment of the Public Worship Regulation Act of 1874. His mind was of a calm statesmanlike cast, and he acted with coolness and dignity in the critical events of his time, such as the Essays and Reviews controversy, the Colenso case and the legal prosecution of Ritualists. He was looked upon by the High Church party as a mere Erastian; they accused him of unfairness, but in his latter days he vindicated his sincerity in professing charitable tolerance with unmistakable clearness. Consult Davidson and Benham, 'Life of Archibald Campbell Tait' (1891); Dangin, 'English Catholic Revival in the XIXth Century' (London 1914).

TAIT, John Robinson, American painter: b. Cincinnati, Ohio, 14 Jan. 1834; d. 1909. He was graduated at Bethany College, Va. (1852), and studied in Florence, Italy (1853–56); in Dusseldorf (1859–71); and in Munich (1873–76). He was for several years the art critic of the New York *Mail and Express.* Among his writings are 'European Life, Legend and Landscape' (1859) and 'Dolce far Niente,' poems (1859).

TAIT, Sir **Melbourne McTaggart,** Canadian jurist: b. Melbourne, 20 May 1842. He was educated at Saint Francis College, Richmond, and was graduated at McGill University, Montreal, in 1862. He started practice as lawyer in 1862 at Richmond, then joined the late Sir John Abbott (1870), remaining his law partner many years. He was created K.C. in 1882 and was elected treasurer of the Montreal bar. In 1887 he was appointed puisne judge to reside at Sweetsbury, province of Quebec, removing to Montreal in 1889. In 1906 he was made chief justice of the Supreme Court. He was knighted on the occasion of the Queen's Jubilee (1897). A founder of the Children's Memorial Hospital, he has been its president since 1905.

TAIT, Peter Guthrie, Scottish physicist: b. Dalkeith, 28 April 1831; d. Edinburgh, 4 July 1901. He was educated at the Edinburgh University and at Saint Peter's College, Cambridge. Elected Fellow of Peterhouse in 1852, he became professor of mathematics at Queen's College, Belfast, two years later, and held that office till his appointment in 1860 to the chair of natural philosophy in the University of Edinburgh. He published 'Dynamics of a Particle' (1856); 'Quaternions' (1867); 'Thermo-Dynamics' (1868); 'Recent Advances in Physical Science' (1876); 'Heat' (1884); 'Light' (1884); 'Properties of Matter' (1885); 'Dynamics' (1895); 'Newton's Laws of Motion' (1899), etc. He was joint-author with Lord Kelvin of a well-known 'Treatise on Natural Philosophy'; and also collaborated with the late Balfour Stewart in 'The Unseen Universe.'

TAIWAN, tī-wän', the native name for Formosa (q.v.).

TAJ MAHAL, täzh, mạ-häl', India, a celebrated mausoleum in a beautiful garden, outside the city of Agra, about a mile east of the fort. It was built by the Emperor Shah Jehan for himself and his favorite wite Mumtaz Mahal, who died in 1629. Tavernier, who saw the building in process of construction, says that 20,000 men were employed upon it continually for 22 years. It is an octagonal building 70 feet high, with sides measuring 130 feet; and is surmounted by a dome giving an additional height of 120 feet; total height, 190 feet. At the four corners of the platform centred by the mausoleum are minarets 133 feet high. The whole is built of white marble, and the interior decorations are of sumptuous magnificence. The screen surrounding the chamber containing the cenotaphs of the emperor and his consort, above the sepulchral vault, is composed of 12 kinds of stones, chief of which is the valuable lapis lazuli; the arabesque mosaic and inlaid work is described as of unsurpassed beauty. The cost of the mausoleum is variously estimated to have been from $10,000,000 to $50,000,000.

TAJURA, or **TAJURRAH,** tä-joo'rä, northeast Africa, a bay and seaport in the French Somali Coast protectorate or territory of Obok, on the Gulf of Aden. It was ceded to France in 1884. The rising French seaport of Jibutil is at the entrance of the bay, on the south side, whence a railway extends since 1902 to Harar. See Abyssinia.

TAK-I-KESRA. See Ctesiphon.

TAKAHASHI, tä'ka-hä'shē, **Korekiyo,** Baron, Japanese financier: b. Sendai, 7 July 1854. He studied English in Japan, then, for one year, in America. In 1875 he was appointed principal of the Osaka English School, becoming (1881) official in the Department of Agriculture and Commerce. In 1892 he entered service of the Bank of Japan, becoming the following year director of its western section. In 1895 he entered the Yokohama Specie Bank as manager, becoming, successively, director (1896), vice-president (1897), and was then appointed vice-governor of the Bank of Japan, returning (1906) to the Yokohama

Specie Bank as president while retaining his former position. From 1904–06 he negotiated important loans from England and America. He was created baron in 1907.

TAKAHIRA, tä'kạ-hē'rạ, **Kogoro,** Baron, Japanese diplomat: b. Iwate, 1854. He was appointed attaché to the legation at Washington in 1879 and became secretary in 1881. Later he was made chargé-d'affaires at Korea, then consul-general at Shanghai and (1887) New York, following which he was successively appointed Minister-Resident to Holland and Denmark, Minister-Plenipotentiary at Rome, Vienna and Berne. From 1901–05 he was minister at Washington, in the latter year signing, with Baron Komura, the Peace Treaty at Portsmouth, N. H. He was Ambassador at Rome (1907), then transferred to Washington the following year, serving till 1909.

TAKAMINE, tạ'kạ-mĭn, **Jokichi,** Japanese-American chemist: b. Takaoka, Japan, 3 Nov. 1854. He was graduated in chemical engineering (1879) at the Engineering College of the Imperial University at Tokio, becoming Japanese government student at the Glasgow University and Andersonian University, Glasgow, from 1879–81. From 1881–84 he was head chemist of the Department of Agriculture and Commerce, Tokio, then (1884–85) Imperial Japanese Commissioner to the Cotton Centennial, New Orleans. In 1887 he organized and erected the first super-phosphate works at Tokio. He came to America in 1890 where he brought a fermentation process to practical use producing diastatic enzyone, now used in starch factories. He established a research factory in New York, and with others, formulated a process of extraction of the active principle of the suprarenal glands on a commercial scale, producing "adrenalin."

TAKAMATSU, tä'kä-mät-soo, Japan, the capital of the prefecture of Kagawa, situated on the north coast of Shikoku. Pop. 40,000.

TAKAOKA, tä'kä-ō'kä, Japan, a town in the prefecture of Toyama near the west coast of central Hondo. It manufactures dyes and hardware. Pop. about 40,000.

TAKASAKI, tä-kä-sä-ke, Japan, a town in the prefecture of Gumma, situated nearly in the centre of Hondo, 60 miles northwest of Tokio, with which it has railroad connection. It has cotton and silk manufactures. Pop. 34,900.

TAKATA, tä-kä'tä, Japan, a town in the prefecture of Niigata, near the west coast of central Hondo. It has extensive manufactures of cotton goods. Pop. 32,600.

TAKIGRAPHY. See Shorthand.

TAKILMAN FAMILY, a tribe of American Indians occupying the country along the Rogue River in Oregon. In 1860 there were some 17 villages of this tribe but it is now scattered or extinct.

TAKOW, tä-kow', or **TA-KAO,** tä-kä-ō', Formosa, a port on the southwest coast, connected by rail with Tainan. Its principal export is sugar. Pop. 15,000.

TAKU, a tribe of North American Indians, residing in the vicinity of Taku Inlet, Alaska. They number about 300.

TALACOGAN, tä-lä-kō'gän, Philippines, a settlement of Moros, province of Surigao, Mindanao, on the Agusan River, seven miles north of the outlet of Lake Pinayat, and 96 miles south of Surigao, the provincial capital. Pop. 11,590.

TALAMANCA, täl-ā-män'kä, Panama, a name formerly applied to the Atlantic Coast region of western Panama and Costa Rica. At the time of the Discovery the region was inhabited by numerous tribes with a peculiar civilization of their own. They manufactured a great variety of ornaments of gold, in which the country was very rich. By the encroachments of the whites they were driven into the forest and mountain recesses. Here a tribe known as Talamancans still lives in practical independence and wholly unaffected by modern civilization, within a short distance of the Panama Railroad.

TALAVACHI, a mysterious poison formerly manufactured by the Aztecs, and by them handed down to the Mexican Indians. Skilfully administered, it is said to destroy the mind while leaving slight effects on the body. The peculiar effect of the poison seems to be to induce monomania or epilepsy.

TALBOT, Arthur Newell, American engineer: b. Cortland, Ill., 21 Oct. 1857. He was graduated (1881) at the University of Illinois, receiving his civil engineer's diploma in 1885. He has been engaged in engineering work on railways, sewerage, waterworks and other public utilities as well as in the investigation of construction material. Since 1890 he has been professor of municipal and sanitary engineering, having charge of theoretical and applied mechanics for the University of Illinois. In 1918 he was elected president of the American Society of Civil Engineers. He has written 'The Railway Transition Spiral' (1901); 'Tests of Concrete' (1906); 'Tests of Columns' (1912); 'Tests of Reinforced Concrete Buildings under Load' (1913).

TALBOT, Ethelbert, American Protestant Episcopal bishop: b. Fayette, Mo., 9 Oct. 1848. He was graduated from Dartmouth College 1870, and from the General Theological Seminary in 1873. He was ordained to the priesthood in the year last named and was rector of Saint James, Macon, Mo., 1873–87. In 1887 he was consecrated missionary bishop of Wyoming and Idaho, and in 1897 was translated to the see of Central Pennsylvania. After administering the diocese of central Pennsylvania for seven years he accomplished its division into the diocese of Bethlehem of which he remained bishop with residence at South Bethlehem, Pa. and the diocese of Harrisburg. He is the author of 'My People of the Plains,' of 'A Bishop Among His Flock' and 'Tim: an Autobiography of a Dog.' Besides these books he has published various sermons, addresses and tracts, etc.

TALBOT, Henry Paul, American chemist: b. Boston, 15 May 1864. He was graduated (1885) at the Massachusetts Institute of Technology and obtained Ph.D. diploma at Leipzig in 1890. He has served successively as assistant (1885–87), instructor (1887–88 and 1890–92), assistant professor (1892–95), associate professor (1895–98) and professor of analytic chemistry (1898–1902) at the Massachusetts Institute of Technology, where he has since had charge of the department of chemistry and chemical engineering. He has written 'Introductory Course of Quantitative Chemical Analysis' (1897); 'The Electrolytic Dissociation Theory,' in collaboration with A. A. Blanchard (1905); besides numerous articles published in the scientific journals.

TALBOT, John, 1st Earl of Shrewsbury: b. about 1380; d. Castillon, France, 17 July 1453. He was appointed lord-lieutenant of Ireland by Henry V in 1414. Five years later he began a long career in the French wars, being present at the siege of Milan in 1420, and at that of Meaux in 1421. He returned to Ireland as lord-lieutenant in 1424 and was knighted in 1426, but in 1427 went again to France. After the raising of the siege of Orléans he determined to save the town of Beaugency; but hearing that the place had already been evacuated, he retreated northward toward Patay, where he was overtaken by the French and captured (1429). He regained his freedom by exchange in 1433. In 1436 he became marshal of France, and by 1439 had become governor and lieutenant-general of France and Normandy. The capture of Harfleur in 1440 was largely due to him. In 1442 he was created Earl of Shrewsbury. In 1445 he conducted Queen Margaret to England, and that year went for the third time to Ireland, where to his titles were added those of Earl of Waterford and Lord of Dungarvan. In 1448 he crossed the channel again as lieutenant of Normandy. In 1453 he went to the assistance of the besiegers of Castillon, and fought against great odds until he was killed.

TALBOT, John, American Protestant Episcopal missionary: b. Wymondham, Norfolk, England, 1645; d. Burlington, N. J., 29 Nov. 1727. He entered Christ's College, Cambridge, became Fellow of Peterhouse in 1664, rector of Freetherne, Gloucestershire, in 1695, and entered the employ of the English Society for the Propagation of the Gospel in Foreign Lands in 1702. He came to America, founded Saint Mary's Church, Burlington, N. J., and was its rector 1704–22. His later loyalty to the Episcopal Church appears to have fallen into question. For the two sides of the controversy consult Hills, 'History of the Church in Burlington' (1876), and Perry, 'History of the American Episcopal Church' (1885).

TALBOT, Silas, American naval officer: b. Dighton, Bristol County, Mass., 1751; d. New York, 30 June 1813. Upon the breaking out of the Revolutionary War he was commissioned captain in a Rhode Island regiment, and after participating in the siege of Boston, accompanied the army in 1776 to New York. For the skill with which he directed certain operations against the British shipping in the harbor he received from Congress a major's commission. He participated in the memorable defense of Fort Mifflin, November 1777, and in 1778 rendered valuable assistance to General Sullivan by transporting the American forces from the mainland to the upper end of the island of Rhode Island. A dashing exploit of the war was his capture in 1778 of the British floating battery *Pigot*, of 22 guns, anchored in one of the channels commanding the approach to Newport. In 1779 he was commissined captain in the navy, and, after cruising with success against British commerce, was captured by a British fleet and confined in the Jersey prison ship 1780. He was afterward removed to England, and in 1781 was exchanged. Upon the reorganization of the navy 1794, he was again called into the public service, and superintended the construction of the frigate *Constitution* (*Old Ironsides*), which in 1799 was his flagship during a cruise in the West Indies. He resigned his commission in 1801, and passed the remainder of his life in New York. Consult Tuckerman, 'Life of Commodore Silas Talbot' (1851).

TALBOT, William Henry Fox, English photographer and scientist: b. Lacock Abbey, near Chippenham, England, 11 Feb. 1800; d. there, 17 Sept. 1877. He was graduated from Cambridge in 1821, and represented Chippenham in Parliament 1833–34. Scientific research being more attractive to him he gave up politics, and, devoting himself to the study of the chemical action of light, made important discoveries in photography. In 1839 his invention of photogenic drawing was explained by Faraday to the Royal Institution, and in 1841 he patented the calotype process. He is still referred to as an authority whose statements are sound. Subsequently Talbot devoted himself to antiquarian research, being one of the first decipherers of the cuneiform inscriptions from Nineveh. His publications include 'Chemical Changes of Color' (*Phil. Magazine* 1828); 'Legendary Tales' (1830); 'Hermes, or Classical and Antiquarian Researches' (1838–39); 'The Pencil of Nature' (6 vols. on photography 1844–46); 'Assyrian Texts Translated' (1856), etc.

TALBOT, or OLD SOUTHERN HOUND, a race of dogs, probably extinct, which seems to have been the original stock from which the various breeds of hounds sprang. The color was pure white; large head, very broad muzzle, long pendulous ears and rough hair on the belly. Talbot is the family name of the English house of Shrewsbury which has a talbot for badge and two talbots for supporters.

TALC, one of the commonest and most important of the non-metallic minerals. It is usually massive or foliated, the laminæ being flexible but not elastic. It is number one in Mohs scale of hardness, and like most very soft minerals it has a greasy feel. Its lustre is pearly and glimmering, and its usual colors are green, gray or white. Foliated varieties are often quite transparent, while the massive is translucent. It is of average specific gravity, about 2.7. It is acid magnesium silicate, $H_2Mg_3Si_4O_{12}$. Talc, like the related mineral serpentine, is of secondary origin, having been formed by the alteration of various magnesian minerals such as tremolite, pyroxene and enstatite. It occurs in metamorphic rocks all over the world, being the most prominent mineral in the rock known as talcose schist, and sometimes forms extensive beds, occurring thus in most of the Atlantic Coast states. Although very soft, it is almost indestructible, not being attacked by acids nor injuriously affected by intense heat. Its common, massive form, popularly known as "soapstone," is the "steatite" of mineralogy. Some soapstone is, however, a massive pyrophyllite (q.v.) and the term soapstone is applied loosely by miners to almost any soft rock or mineral with a greasy feel. Talc is used in the arts either powdered as "flour talc," or in sawed pieces. Flour talc is employed as a base for fireproof paints, in boiler and steampipe coverings, and foundry facings, for electric insulators, in the manufacture of dynamite, and of wall papers to which it imparts a glossy surface; it is very extensively used in the manufacture of toilet powders, and cheap soaps, for dressing leathers and skins, and as a base for lubricants. About half a million dollars' worth of «fibrous talc» is produced annually in the single county of Saint Lawrence in New York. This material is a mixture of talc and fibrous tremolite and is used in making paper. When ground the fibres cause the retention of the flour talc in the paper pulp, thus adding materially to the strength and weight of the paper. The supply of pure, compact soapstone, the most valuable variety of talc, comes largely from western North Carolina and Virginia. It is sawed into slate pencils and crayons and is manufactured into the tips of gas burners. The chief uses of soapstone are for stationary washtubs, sinks, acid tanks, hearth-stones, fire bricks, mantels, griddles and many other articles of everyday use. «French chalk» is a fine-granular talc used as a crayon by tailors. In China and Japan a fine compact talc is carved into various ornaments, household gods and pagodas, though considerable of the material thus used is agalmatalite (q.v.) or pyrophyllite. See MINERAL PRODUCTION OF THE UNITED STATES.

TALCA, täl'kä, Chile, the capital of the province of the same name, on the Rio Claro, about 180 miles south of Valparaiso, on the railway from Curico to Concepcion. It is a fine city, with handsome churches and a lyceum. Weaving is the chief manufacturing industry. Pop. (1916) 41,618. The province has an area of 3,864 square miles and the population is 131,058.

TALCAHUANO, täl-kä-wä'nō, Chile, a seaport in the province of Concepcion, situated 260 miles south of Valparaiso, and eight miles west of the city of Concepcion, with which it has railroad connection. It has a lighthouse, a new custom-house, a wireless station, and large warehouses and docks. The harbor is being fortified. It is the principal export town for wheat in southern Chile. It suffered severely from earthquake in 1835, but was rebuilt. Pop. 21,876.

TALE OF A TUB, A, and THE BATTLE OF THE BOOKS. Swift's 'A Tale of a Tub' was written for the most part about 1696, but was not published till 1704, when it appeared in a volume with 'The Battle of the Books.' The author wittily dedicated it to Prince Posterity, and to this day it has generally been regarded as one of the two or three great prose satires in English. Not the least interesting parts of it are the digressive chapters on critics and criticism and on madness, in which the theory is advanced that happiness consists in being well deceived. Its most fruitful fancy is of the sect who took the tailor for their idol, and held the universe to be a large suit of clothes — the germ of Carlyle's 'Sartor Resartus.' The allegorical narrative presents the fortunes of three brothers, Peter, Martin and Jack, standing respectively for the Roman, the Anglican, and the Dissenting churches. Their father on his death-bed bequeathes them each a coat with two virtues: «One is, that with good wearing they will last you as long as you live. The other is, that they will grow in the same proportion with your bodies.» For a time the boys wear their coats in accordance with their father's will. Later they come up to town and fall in love with the three ladies then most in reputation, the Duchess d'Argent, Madame de Grands Titres and the Countess d'Orgueil. Desiring to be in the fashion they violate their father's will, covering their coats with shoulder-knots, silver fringe and figured embroidery. Peter becomes dictatorial and insists on being addressed by his brothers as Mr. Peter, Father Peter and finally as My Lord Peter. Martin and Jack revolt from his authority, and, in token of repentance, attempt to remove the embellishments from their coats, in which process Martin, reforming with moderation, restores his garment to something like its original state, but Jack in a fanatical fury rends his from top to bottom. Swift asserted that he had written as a good churchman, ridiculing only Popery and Dissent. The wits were delighted with his attack; but sober Anglicans were alarmed at its implications; and it is undeniable that its disgusting coarseness and brutal levity were inimical to every form of religious reverence. The satire was assailed and explained by William Wotton; but his explanations were maliciously seized upon and made to serve as annotations in subsequent editions. As an old man Swift is said to have exclaimed: «Good God, what a genius I had when I wrote that book.»

'The Battle of the Books,' written about 1697, was Swift's contribution to the famous literary controversy of the 17th century regarding the relative merits of ancient and modern writers. In England the discussion was rendered rather insignificant by the curious confusion of the champions, the wits of the day appearing as defenders of the ancients, and the great classical scholar of the age as a leader of the moderns. The conflict was opened over the 'Letters of Phalaris,' which Sir William Temple, in his 'Essay Upon the Ancient and Modern Learning' (1692), declared «have more of grace, more spirit, more force of wit and genius than any others I have seen, either ancient or modern» — yet the 'Letters of Phalaris,' said Temple, is one of the two most ancient books in prose that we possess. William Wotton, championing the moderns, replied in 1694 with 'Reflections Upon Ancient and Modern Learning.' In 1695 Charles Boyle brought out an edition of the extolled *Letters*, in behalf of the ancients. In 1697 Wotton published a second edition of the 'Reflections,' including an essay by the learned Richard Bentley, showing that the 'Letters of Phalaris' were forgeries and, relatively, *modern*. At about this point Swift comes in with his 'Battle of the Books,' written for the defense of the ancients and in support of his patron, Temple, the immediate object being to turn the laughter of the town upon Wotton and Bentley. Swift was on the wrong side with respect to the Phalaris question and with respect to the scholarship of the enemy. But he releases a flight of nicely pointed arrows against pedantry and sour-tempered criticism and the vanity and egotism of the modern spirit. In the course of the dispute between the Spider and the Bee he strikes out an idea and a phrase which Matthew Arnold adopted and popularized

as the epitome of his gospel of culture — "sweetness and light." Consult lives of Swift by Samuel Johnson, Sir W. Scott, J. Forster, H. Craik, L. Stephen, P. M. Simon, etc.; also Saintsbury's 'History of Criticism'; Spingarn's 'Critical Essays of the Seventeenth Century'; 'Cambridge History of English Literature' (Vol. IX). STUART P. SHERMAN,
Professor of English, University of Illinois.

TALE OF TWO CITIES, A, published in 1859, was the second of Dickens' historical novels and is to-day more popular than the author's earlier novel of the same kind, 'Barnaby Rudge' (1841). The reason lies partly in the fact that the French Revolution is a more permanently interesting historical event than the anti-Catholic agitation and the Gordon riots in London. The chief purpose of the novel is to give an impression,— in this case a very English impression with its roots in the anti-Napoleonic tradition,— of the days of the old Régime and the French Revolution, in which cynicism, arrogance and cruelty, on the one hand, and uncouthness, violence and guillotining, on the other hand, were the prominent features. No account is suggested of the intellectual causes of the Revolution. It is a picture of action. The turbulence of Paris compared with the dignified and law-abiding ways of London give the book its title. The story is the account of the escape from France of the emigré, Saint Evremonde, or Charles Darnay, of his return to France, his arrest, condemnation through the unwitting evidence of his own father-in-law, Dr. Manette, and his final escape through the self-sacrifice of Sidney Carton. This last is the most famous part of the book, both ethically and episodically. Sidney Carton, the real hero, takes advantage of his resemblance to Charles Darnay to mount the scaffold in place of the latter, who is meanwhile hurrying disguised to England with his family. The story is a moving one and is almost wholly lacking in the usual humorous scenes and characters of the author. It has been successfully dramatized. Certain of the scenes, as notably the flight from Paris, the death of Carton, and the women knitting indifferently at the executions, have become famous. WILLIAM T. BREWSTER.

TALENT, the name of a weight and denomination of money among the ancient Greeks, and also applied by Greek writers to various standard weights and denominations of money of different nations; the weight and value differing in the various nations and at various times. The Attic talent as a weight contained 60 Attic minæ or 6,000 Attic drachmæ, equal to 56 pounds, 11 ounces, British troy weight. As a denomination of silver money it was equal to $1,220. The great talent of the Romans is computed to be equal to $500, and the little talent to $375. A Hebrew weight and denomination of money, equivalent to 3,000 shekels, also receives this name. As a weight it was equal to about 93¾ pounds avoirdupois; as a denomination of silver it has been variously estimated at from $1,500 to $1,880.

TALES OF THE ARGONAUTS, The. 'The Tales of the Argonauts' is a volume of short sketches collected and published by [Francis] Bret Harte in 1875; but the title is sometimes loosely applied to all this author's stories of early California. Nothing in the 'Tales of the Argonauts' proper quite equals in merit 'The Luck of Roaring Camp,' 'The Outcasts of Poker Flat' and 'Tennessee's Partner,' which had appeared in an earlier collection; but 'An Iliad of Sandy Bar,' 'How Santa Claus Came to Simpson's Bar,' and some others have been deservedly popular. The Argonauts are of course the gold-seekers of 1849 and the years immediately following. These adventurers came from all quarters of the globe and all ranks of society, and they had in common only the possession of the strength and determination necessary to reach the new Colchis. Here they lived, at first, wholly free from the conventional restraints imposed by an organized society, and each man showed himself for what he was. Many of these primitive social conditions still existed when Harte went to California in 1854, and they made a great impression on the observant boy. He did not use them in literature, however, until he was able to look back on them in the light of a man's experience. Californians objected that his pictures were unreal; but they give the impression of essential truth to life — an impression not spoiled by his persistent habit of showing the good elements in even the lowest and most debased characters. Harte occasionally seems to have adopted some of the less fortunate devices of Dickens, but his manner was chiefly his own. He lacks literary finish, though he was painstaking in regard to style; but in these early tales he has a sure command of humor and pathos, and a complete mastery of his unique material.
WILLIAM B. CAIRNS.

TALES OF THE CRUSADERS, two novels by Sir Walter Scott, respectively entitled 'The Talisman' and 'The Betrothed.'

TALES OF A GRANDFATHER, a collection of stories dealing with the history of Scotland, by Sir Walter Scott, and published in four series in 1827–30.

TALES OF HOFFMAN (*Les Contes d'Hoffman*), Opera comique in prologue and three acts by Jacques Offenbach (libretto by Barbier), first produced at Paris, 10 Feb. 1881, several months after the composer's death. In spite of the unparalleled success which Offenbach had achieved with his light-hearted, clever and unfailingly melodious *operas bouffes,* he evidently desired to bequeath to posterity a work of more serious artistic import; and he spent his most ambitious efforts and years of his life on the 'Tales of Hoffman.' As his end approached, he begged the manager to produce it in time for him to witness the première. While he did not live to see it, the public took to the work no less heartily than to the operettas and it will undoubtedly outlive them. The story is novel and cleverly put together. The prologue shows Hoffman and his fellow students in Luther's Inn at Nuremburg; he is persuaded to tell of his three love encounters and these form the three succeeding acts. The opera ends as it began, Hoffman acclaimed a hero by his admiring friends. Inspired by its romance and fantasy, Offenbach has written a genuinely attractive score, which displays his talent for melody-making and ingenious characterization at its best. The barcarolle, in the second act, once heard, is never to be forgotten. Alone it would have made the opera, but there are many other numbers worthy of recall — the burlesque ballad of Kleinzach, sung by Hoffman in the prologue and epilogue, Nicklausse's song of the doll, the automaton's song, «Les oiseaux dans la charmille,» Antonia's romance, «Elle a fui,» and the trio finale of the third act. Offenbach's treatment of the dramatic situations is always clever and at times subtle. The orchestration, while simple, is refined and the general artistic level of the work greatly above that on which he was usually content to stand. In Europe, 'Tales of Hoffman' has been pursued by superstitious fear on the part of the managers owing to the fact that its first performance at the Ring Theatre in Vienna was the occasion of a conflagration which caused great loss of life. Its revival in New York by Oscar Hammerstein in 1907 proved that its original appeal is still potent.

LEWIS M. ISAACS.

TALES OF MY LANDLORD, a name applied to four series of Scott's novels, the first embracing 'Old Mortality' and 'The Black Dwarf'; the second, 'The Heart of Midlothian'; the third, 'The Bride of Lammermoor,' and 'A Legend of Montrose'; and the fourth 'Count Robert of Paris,' and 'Castle Dangerous.'

TALES OF A TRAVELLER, a well-known work by Washington Irving, published in 1824. It is a delightful medley of humorous and tragic elements and the author himself declares them to be «moral tales,» with the moral «disguised as much as possible by sweets and spices.»

TALES OF A WAYSIDE INN. The 'Tales of a Wayside Inn,' by Henry Wadsworth Longfellow, was published in three parts, in 1863, 1872 and 1873, respectively. The poet followed the old plan of presenting a series of stories as told by different persons — in this case by friends of the author who, though they were not named, were so plainly characterized as to be easily recognizable. Among those of wider fame are Ole Bull, the violinist, and Thomas William Parsons, the poet and translator of Dante. The «Wayside Inn» was the old Red Horse Inn at Sudbury, 20 miles from Cambridge — a favorite resort for parties from Harvard College. Each of the three parts has a *prelude* and a *finale*, and there are *interludes* which link together the tales and introduce the narrators. Most of the stories were derived by Longfellow from his wide reading — many of them from the legends of continental Europe, a few from American sources. The 'Birds of Killingworth' was developed from so slight a hint that it may fairly be said to be of the poet's own invention. Longfellow, while not a poor story-teller, was hardly at his best in narrative, particularly in narrative with vigorous action, and the 'Tales of a Wayside Inn,' taken as a whole, is not to be listed among his most distinguished works. A few of the Tales have, however, won a place for themselves. Among these are 'Paul Revere's Ride,' told by the Landlord, and 'King Robert of Sicily,' which is ascribed to the Sicilian.

WILLIAM B. CAIRNS.

TALESMAN. From the Latin *talis*, such, or of such a kind and quality. A talesman is a juror summoned to fill up a panel for the trial of a particular case. A default of jurors appears to have but one immediate remedy in common law, that is to select *tales de circumstandibus* (those bystanders who are competent) in sufficient number to make up the jury. A number of statutes forbid summoning bystanders but the procedure is maintained in most jurisdictions, and the method is considered legal unless forbidden by statute. There appears to be no set limit as to the extent of the emergency requiring talesmen beyond that of the panel being exhausted and deficiency of jurors existing. Talesmen can only be summoned for a single trial, not for a circuit. Talesmen are considered strictly as *additional* jurors, not called to form a new panel. In some States it has been held that the jury may be made up entirely of talesmen when all the panel has been discharged or taken on to some other case or when a «challenge to the array» has been sustained, but such right of action has been denied and the usual method employed is to issue a new venire.

TALFOURD, tâl'fẽrd, SIR **Thomas Noon,** English poet: b. Reading, 26 May 1795; d. Stafford, 13 March 1854. He was called to the bar in 1821, but in early life mainly supported himself by literary labors, as a contributor to various periodicals. In 1835 and 1837 he was returned to Parliament as one of the members for Reading; and between these years produced at Covent Garden his tragedy of 'Ion.' The tragedies subsequently written by him were 'The Athenian Captive'; 'Glencoe, or the Fate of the Macdonalds'; and the 'Castilian.' None of these had the same success as the first. As a dramatist his excellence lies more in beauty of language and sentiment than in power of dramatic action. In 1849 he was raised to the bench in the Court of Common Pleas and knighted. He died suddenly while charging a grand jury. Besides the dramas above referred to, he was the author of 'Life of Charles Lamb' (1837); and the same in a much enlarged edition (1848).

TALIAFERRO, tŏl'ĭ-vẽr, **William Booth,** American soldier and lawyer: b. Belleville, Gloucester County, Va., 28 Dec. 1822; d. there, 27 Feb. 1898. He was educated at Harvard and at William and Mary College, being graduated from the latter in 1841. He then studied law, and was engaged in the practice of his profession until 1847, when he became captain in the United States infantry; later he was promoted major; and in August 1848 was mustered out and resumed his law practice. At the outbreak of the Civil War he became colonel in the provisional army of Virginia; in 1862 he was promoted brigadier-general in the Confederate army and in 1865 major-general. He commanded at Gloucester Point, Va., took part in most of the battles of the Army of Northern Virginia until March 1863, when he was given charge of the district of Savannah, Ga. In July 1863 he was in command of the troops and defenses on Morris Island, and gallantly defended Fort Wagner (q.v.) against a combined land and naval attack. Later he was in command of the district of South Carolina. After the war he was elected to the State legislature and served 10 years during the Reconstruction period. He was prominent in the Masonic fraternity and was Grand Master of the Masons of Virginia in 1876–77.

TALIESIN, British bard or minstrel of the 6th century. To him are attributed about 56 poems, which many critics consider of later origin. Consult Skene, 'Four Ancient Books of Wales' (1868); Guest, 'Mabinogion' (1877).

TALIM, tä-lēm', an island of the Philippines, in the centre of the Bay Lagoon, Luzon, separated from a peninsula on the southern coast of the province of Rizal by a channel about half a mile wide; length from north to south, 10 miles; width, four miles; area, 20 square miles. A central mountain range traverses the island from north to south; there are villages along the coast on each side. Building stone is obtained in the mountains and sent to Manila.

TALIPOT, a palm (*Corypha umbraculifera*) of Ceylon and India, remarkable for possessing the largest inflorescence of any plant. The straight, cylindrical trunk takes over 50 years to attain its full height; during 30 of those years the leaves spring from near the ground, but afterward the palm grows rapidly until it is 70 feet tall. It then sends up from the centre of the crown a gigantic, pyramidal flower-panicle, with a main rachis over 30 feet long, and a dozen branches reaching so far out that the base of the panicle also is about 30 feet across. These branches terminate in many branchlets and twigs, and are covered with possibly 100,000 greenish-yellow, diœcious blossoms, which have so powerful and disagreeable an odor that the tree is often cut down at this stage. As soon as the tree begins to bloom the leaves fade, and by the time the flowering period (about a month) has ended, they have often all fallen off, leaving the bare, ringed trunk crowned only by the inflorescence. After a year's time the fruits, which are inedible, are matured and fall in great quantities, and the whole tree dies down, having lived to produce only this single exhausting crop.

The leaves also are gigantic, one alone being capable of sheltering 10 persons comfortably. They have prickly stalks six or seven feet long and are more or less circular, with radiating ribs of the texture and strength of rattan, and plaited, narrow segments which are joined together nearly to the tips, and can be folded like a fan. They can be easily marked with a metal point and are used as writing material to some extent by the natives and Buddhists. They are of coriaceous texture when dry, and are valuable for thatching houses, for umbrellas, fans and basketry, and are carried before Singhalese of rank. In times of famine the trunks are felled, for the sake of their pith, which produces a kind of sago.

TALISAY, tä-lē'sī, Philippines, pueblo, province of Cebu, on the east coast, six miles southwest of Cebu, the provincial capital. It is on a short branch of the coast highway connecting it with towns to the north and south. Pop. 19,000.

There are also two smaller pueblos of the same name: (1) in the province of Ambos Camarines, Luzon, two miles northwest of Daet; pop. 3,560; (2) in the province of Batangas, Luzon, on the north shore of Lake Bombon (Taal), 26 miles north of Batangas; it is near a pass from Batangas to Cavite; the chief industry is fishing; pop. 8,200.

TALISMAN, a small object presumed to possess an astrological or mystical charm that may protect or guard the owner in some way. It was usually of stone or metal and bore an engraved figure, and gained its suggested value because of certain ceremonies, at some particular moment, as at the culmination of a certain star or at the conjunction of certain planets. The talisman was supposed to exercise supernatural influences over the bearer or owner, particularly in averting disease. The nature of the talisman has been very different among different nations. The Egyptians made use of images of their gods and of sacred animals, such as the ibis and the scarabæus; the Jews used the phylacteries inscribed with passages from the Old Testament (a section of the cabala is devoted to teaching the construction of talismans); the Greeks used little tablets having written upon them various magical words, such as the Ephesian words, or those written on the feet, the girdle and the crown of the statue of Artemis at Ephesus; the Romans employed various idols, which they suspended upon the body by chains; the Arabians and Turks made use of sentences from the Koran; and we also find in the East medals of particular metals struck under a particular constellation and marked with magical signs. In the Middle Ages astrology and the knowledge of the virtues of talismans and amulets formed an important part of medical science; and the quacks of modern times sometimes have recourse to similar means. The talisman differs from the amulet, in that it does not require to be worn or carried, but like Aladdin's lamp will work wonders. See FETISH.

TALKING MACHINE. The wonderful, though natural, growth in popularity of the talking machine has caused its manufacture and sale in the few years that have passed since its perfection to become a truly great industry. Its utility for entertainment purposes in the home no doubt aids in the absorption of most of the instruments constructed in the competing factories, but the use of talking machines in commercial life (dictaphone perhaps in particular), greatly aids the numerical demand and it is found a valuable aid in teaching foreign languages. History mentions talking machines as early as the 13th century, when Albertus Magnus, the philosopher and scholar, is said to have produced a mechanism that reproduced the human voice. A queen of Sweden is said to have had a head which talked automatically in Hebrew, Greek, Latin and French. The Reverend John Wesley writes in his journal at date 26 April 1762, that he saw an invention at Lurgan, Ireland, of startling capabilities. It was "an automaton of an old man in a case over against a clock . . . Every time the clock struck he opened the door with oue hand, drew back the curtain with the other, turned his head, . . . then said with a clear, loud articulate voice, 'Past one, two, three' and so on." The invention was contrived by a man named Miller. But so many visitors called from foreign parts to see this wonder, and no one offered to purchase it, that it took up his time so much he nearly failed in business and he "took the whole machine to pieces." This Miller told the preacher later he had made very successful experiments and could make a man who could talk and sing hymns, but he was too busy on other work. In 1783 Abbé Mical presented to the French Academy of

Sciences an invention that talked, but he later broke it up, having religious scruples.

In 1877 Thomas Alva Edison brought out his first talking machine. The contrivance was of the simplest, being merely a steel point fixed to the centre of a flexible disc and a revolving cylinder behind the point. It was first displayed in Paris. The invention was enclosed in a little box about a foot square and the record was made on a piece of tin-foil. As a wonderfully clever toy sold at small expense it created great admiration. In 1888 Edison constructed his phonograph with its diaphragm having the lateral movement instead of the cylinder and the sheet of tin-foil was discarded in favor of a cylinder of wax, the vibrations being recorded with a tiny chisel. Edison is said to have gained his incipient conception of a talking machine while working with automatic telegraphs operating at high speeds. He made some experiments with embossed strips impressed with dashes and dots thereon which were moved rapidly beneath a stylus to vibrate it. He observed the stylus made audible sounds while vibrating, and as the great inventor never passed by mechanical facts, however trivial they might appear to the ordinary investigator, he became interested in this curious sound phenomenon. He was about this time working on telephone experiments and the idea of a new sound developer occurred to him as a possibility. The conception of developing a talking machine soon grew in his mind and under his expert hands he soon had his first talking machine — getting his first patent 19 Feb. 1878, No. 200,521, with its tin-foil records.

The graphophone was an outcome of much experimentation by laboratory experts and at its inception the sewing machine was becoming a highly popular home machine. Therefore the manufacturers at first used the sewing-machine stand (frame, treadle and table top) in their first output, as motive power which was manufactured in the East Bridgeport vacated building of the Home Sewing Machine Company. It met with poor success and the spring motor was invented which made it portable and sales grew rapidly. Next the cylinder form of record was discarded for the disc form of record. The listener had been using a pair of tubes for the ears. these gave way to the horn for the dissemination of the sound leaving the ears naked and the sound audible at a distance. Later again the ungainly horn and all the mechanism was enclosed in a box or a cabinet.

Emil Berliner invented the gramophone aparatus in 1892 with a smoked disc and stylus to produce sound vibrations. See GRAMOPHONE, GRAPHOPHONE, PHONOGRAPH, etc.

TALL FESCUE. See GRASSES IN THE UNITED STATES.

TALL OAT-GRASS. See GRASSES IN THE UNITED STATES.

TALLADEGA, tăl-ạ-dē'gạ, Ala., city, county-seat of Talladega County, on the Southern, the Birmingham and Alabama, the Louisville and Nashville and Atlanta, Birmingham and Atlantic railroads, about 70 miles east of Birmingham and 100 miles north of Montgomery. In the place where the city now stands, General Jackson had an encounter in 1813 with a large band of Cherokee warriors. Jackson was victorious. The city is in a fertile agricultural region, in which there is also considerable mining. The chief industrial establishments are three cotton factories, two machine shops and grist mills, the $200,000 chemical plant, cottonseed-oil mill, three lumber and planing mills. There is considerable trade in grain and cotton. The educational institutions are the Synodical Female College, Alabama Academy for the Blind, Alabama School for the Deaf-Mutes, Alabama Institution for Deaf, Dumb and Blind Colored Children, Talladega College (colored), opened in 1869, under the auspices of the Congregational Church, and public schools. There are several churches and one orphanage. The two national banks have a combined capital of $150,000, State bank $50,000, deposits over $1,000,000. Pop. about 5,854.

TALLADEGA, Battle of, in the War of 1812. On 7 Nov. 1813, four days after the battle at Tallishatchee Jackson learned that 160 friendly Creek Indians in Lashly's Fort at Talladega, about 30 miles south of Fort Strother, were besieged by 1,080 hostile warriors and were in danger of capture. Accordingly, with 1,200 infantry and 800 cavalry, he set out and on the 9th had approached within 80 yards of the Indians before he was discovered. Jackson arranged his plan of battle so that the Indians would be surrounded, but in the fight three companies of militia gave way and allowed many Indians to escape. Jackson's victory was decisive, 290 of the enemy being found dead on the field while his own loss was 15 killed and 85 wounded. Jackson returned to Fort Strother 10 November where he was forced to remain idle until the battle of Emuckfaw (q.v.). Consult Brackenridge, H. M., 'History of the Late War,' pp. 190–191; Lossing, 'War of 1812,' pp. 763–766; Wiley and Rines, 'The United States,' Vol. V, pp. 448–449; biographies of Jackson by Parton (Vol. I, pp. 440–444); Buell (Vol. I, pp. 306–310) and Frost (pp. 142–346).

TALLADEGA COLLEGE, located at Talladega, Ala. It is open to all persons without regard to color or race, but is practically for the education of the negro race, and its work is arranged to meet their needs. It was founded in 1867 by the American Missionary Association (Congregational), aided by the Freedman's Bureau; and was the first college open to colored pupils in Alabama; the charter was obtained in 1869. A farm was bought in 1877, additions to it were made in 1887 and 1902 until the land owned by the college includes about 800 acres. The college is coeducational and aims to secure the best development of social character by the association of students of both sexes under the same general discipline and careful supervision. The college organization includes seven departments. The theological department offers three courses, the classical course including the study of the Bible in Hebrew and Greek, leading to the degree of D.D.; the English course, the same as the classical without the study of the Bible in the original languages; the Bible training course, of two years, including almost entirely special study of the Bible without the other studies of the usual theological course. The college department offers two courses, the classical and the scientific, leading to the degrees of A.B.

and BS.; and the college preparatory department has two corresponding courses of three years, differing only in the last year. The normal course requires four years' work beyond the grammar grades, the first year being the same as the first year of the college preparatory; it includes practice work in the primary and intermediate grades. In the department of music singing lessons are a part of the curriculum in all grades, in addition to which there is more advanced work in vocal music and in pianoforte. Industrial training has always received attention at the college. Students do the greater part of the work on the farm and in the care of the dormitories, laundry, etc., some give the day to this work and study in night classes. There are also printing and carpentry work provided; student labor has had a part in the erection of most of the buildings. Different groups of girls in the college department have entire charge of the housekeeping in Foy Cottage, the girls' industrial house. In addition to this instruction is given the boys in the third to seventh grades in woodworking and drafting, in the eighth grade in forging, and to the girls in the third to seventh grades in sewing and dressmaking and in the eighth grade in cooking. Instruction is also given to students in the preparatory and normal departments in agricultural subjects and in nurse training. The college buildings are situated on high ground about half a mile from the city; they include Swayne Hall (the main college building), Graves Hall (theological building), Foster Hall (women's dormitory), Stone Hall (men's dormitory), Cassedy School (primary and intermediate grades), Foy Cottage (girls' industrial house), the Slater Shop (for boys' industrial work), a library building, the De Forest Memorial Chapel, also the laundry, printing office and houses for teachers. The college ranks among the leading negro educational institutions in the South, and has won the respect and confidence of the white men of the community. Its productive funds in 1917 amounted to $256,000; it is also assisted by the American Missionary Association; the library contained 16,500 volumes; the students numbered 707, and the faculty 40.

TALLAHASSEE, tăl-a̤-hăs'ē, Fla., city, capital of the State, county-seat of Leon County, on the Dixie highway and the Old Spanish Trail highway, on the Georgia, Florida and Alabama and the Seaboard Air Line railroads, 205 miles east of Pensacola, Fla., and 163 miles west of Jacksonville. It is in an agricultural, stock and fruit-growing region and ships considerable fruit. The chief industries are cotton compresses, cotton gins, railroad shops, novelty works and cigar factories. There are 10 churches, six of which are for the colored people. The educational institutions are Florida State College for Women which has a teachers' normal school attached, founded in 1857; West Florida Seminary, University, founded in 1884, separate public schools for white and colored children. There are three libraries. Tallahassee has five banks, three State banks and two private banks, capital $220,000; surplus $56,250. The water-supply, for domestic purposes, comes from artesian wells. The city owns the gas, water and electric light plants. Franchise for an electric street and interurban railway was granted in 1916. Temperature in summer ranges from 82° to 98°. Tallahassee is 21 miles from Saint Marks on the Gulf, where there is fresh and salt water fishing; much large game still abounds in this section. Pop. about 7,000.

TALLAHATCHIE, tăl-a̤-hăch'ĭ, a river which has its rise in Tippah County, in northern Mississippi, flows southwest, and unites at Greenwood with the Yocona to form the Yazoo River. It is about 220 miles long and navigable for 100 miles.

TALLAHATCHIE, Battle of, in the War of 1812. When news of the massacre at Fort Mims (q.v.) 30 Aug. 1813 reached Nashville, Tenn., Gen. Andrew Jackson (q.v.) collected 2,500 infantry and 1,000 cavalry, crossed Tennessee into what is now Alabama, on 23 Oct. 1813 established a camp called Fort Deposit and early in November reached the headwaters of the Coosa. Learning that the Indians had posted themselves at Tallishatchee on the south side of the Coosa, about 13 miles distant, Jackson sent Col. John Coffee with 920 troops to destroy them. By a rapid march Coffee reached the Indian camp 3 November and was boldly charged by the Indians but repulsed them and killed all, about 200 in number, with a loss to himself of 5 killed and 41 wounded. Jackson then moved toward Talladega (q.v.). Consult Brackenridge, H. M., 'History of the Late War,' (p. 190); Fay, H. A., 'Official Accounts' (pp. 143–145); Lossing, 'War of 1812' (pp. 758–763); Wiley and Rines, 'The United States' (Vol. V, pp. 447–448); biographies of Jackson by Parton (Vol. I, pp. 430–438), Buell (Vol. I, pp. 302–304) and Frost (p. 132 et seq.).

TALLAPOOSA, tăl-a̤-poo'sa̤, Ga., city in Haralson County, on the Southern Railroad near the Alabama line, about 53 miles west of Atlanta. It is in an agricultural region, in the vicinity of pine forests. There is considerable iron ore in the vicinity and near the city are large vineyards. Its industries are connected with the culture and shipping of grapes, with cotton, farm and lumber products, and mining. There are banking facilities and newspapers. Pop. 3,000.

TALLAPOOSA, a river which has its rise in Paulding County, Ga., and flows southwest into Alabama. It unites with the Coosa about five miles north of Montgomery and forms the Alabama River. It is about 245 miles long and navigable for 40 miles.

TALLEGALLA. See MEGAPODES.

TALLEYRAND-PÉRIGORD, tăl-ā-rôṅ (Eng. tăl'ĭ-rănd) pā-rē-gōr', **Charles Maurice de**, French diplomatist: b. Paris, 13 Feb. 1754; d. there, 17 May 1838. Although the eldest of three brothers he was, in consequence of lameness, prevented from entering the army and destined, against his will, for the priesthood. He commenced his studies at the College d'Harcourt, continued them at the Seminary of Saint Sulpice and at the Sorbonne, and completed them at Rheims, where an uncle of his was archbishop. His life of restless activity is naturally divided into three parts: namely, from his consecration as bishop (1789) to his banishment by the Convention; from that period to the Peace of Paris 1815; and from the return of constitutional government to his death. In 1780, when only 26, he was appointed general agent to the clergy, and in 1789 he was consecrated bishop of Autun. As he found his spiritual functions inadequate to satisfy his ambition, he attached himself to Mirabeau, then connected with the Minister of Finance, Calonne. Here his political career began Mirabeau recommended the abbé to the Minister. Hitherto Talleyrand, at the court of Versailles, had displayed all the qualities of a polished, witty and gallant courtier. But he now left the court party and joined the Republicans, and on the meeting of the States-General was elected deputy for Autun, and voted soon after they opened for merging the three estates into one national assembly. In vain the court tried to stop him in his career. After the storming of the Bastille he was chosen by the national assembly one of the committee which was to issue an account of their proceedings. His popularity was greatly increased by the leading part which he took in urging the confiscation of clerical property. At this time he founded, in concert with Lameth, Barnave, Lafayette, Mirabeau, Siéyès, and Sailly, the Society of the Friends of the Constitution, out of which the Jacobin Club afterward arose. He soon retired from it, however, as too extreme, and in 1789 founded the society known as the Club des Feuillants. Here he exerted himself for a monarchy, surrounded by democratic institutions. On 16 Feb. 1790, he was elected president of the national assembly, and on 14 July of that year, the first anniversary of the fall of the Bastille, presided in that capacity at the memorable solemnity of national federation in the Champ de Mars. About this time he was the author of various important administrative proposals, a registration scheme which was adopted, and forms the basis of that still in force in France, and a plan of a system of public education which was of great service to the subsequent assemblies which took up the problem. When the civil constitution of the clergy was framed he gave his adhesion to it and he ordained the first constitutional clergy. For this he was immediately excommunicated by a Papal brief, and embraced the opportunity to renounce his episcopal functions (April 1791). On two occasions in 1792 he was sent to London charged with diplomatic functions, although bearing no official position. After his return on the second occasion (August 1792), he was accused of cherishing royalist sympathies, but Danton rescued him and sent him back to London (September). But the charges against him gained strength; and by a decree of the Convention he was placed on the list of emigrants, which precluded his return to France. His power under the Directory was now forever lost, although by the intervention of Madame de Staël the decree against him was recalled in 1795. After his arrival in Paris the opposition which he met with from Carnot prevented him from being employed, and kept him in bad odor. At last, by exerting himself in the Constitutional Club, he succeeded in 1797 in gaining the Ministry of Foreign Affairs; but being suspected of keeping up an understanding with the agents of Louis XVIII he was obliged to resign in July 1799, and his downfall as a republican was complete. But he had early recognized Bonaparte as the coming man in France and after the latter's return from Egypt did much toward bringing on the critical event of the 18th Brumaire (10 Nov. 1799), when the Directory fell and the Consulate began. Appointed Minister of Foreign Affairs, he took the lead in the negotiations for the Treaties of Luneville and Amiens. In 1803 he married a Mrs Grand, with whom he had been living for some years. They separated in 1815. He became an uncompromising promoter of the Napoleonic idea, was a chief instigator of the murder of the Duc d'Enghien in March, and after the establishment of the empire in 1804 was appointed to the office of grand-chamberlain. In December 1805, after the conclusion of the campaign against Austria, he negotiated the Peace of Presburg, and in the following year exerted himself for the elevation of Louis Bonaparte to the Dutch throne. On 6 July 1806, he was created Prince of Benevento. After the battle of Jena he was very active, and concluded the Peace of Tilsit with Russia and Prussia (July 1807). From this time, from what cause is not well known, a coolness arose between him and Napoleon, and became more and more marked. In 1808 he secretly joined a Royalist committee, and in conjunction with Fouché began to intrigue for Napoleon's downfall. On the first news of the unsuccessful issue of the Russian expedition, he placed himself in communication with Louis XVIII, joined the Congress of Chatillion, received the Emperor of Russia into his hôtel, and on 1 April 1814, established a provisional government, placed himself at the head of it, and procured Napoleon's abdication. He afterward exerted himself very effectually in re-establishing Louis XVIII on the throne of his ancestors. He was at the Congress of Vienna when news arrived that Napoleon had landed from Elba. He took part in the declaration then issued characterizing Napoleon as a disturber of the peace. When in 1815 the Allies again entered Paris he again became president of the council with the portfolio of Foreign Affairs; but as he refused to sign the second Peace of Paris he gave in his resignation.

With the commencement of constitutional government in France and the internal struggles connected with it Talleyrand's principal career was properly concluded. In the first years of the Restoration he often appeared at the palace and gave good counsel, of which the reigning party made no use. In the house of peers he often voted with the opposition, defended the freedom of the press, and condemned the Spanish campaign of 1823.

When he saw the rocks on which the Restoration would be wrecked he retired to Valençay, keeping open house, and giving a welcome reception to all who had distinguished themselves either by literary or political service. In his social intercourse Talleyrand always exhibited the grandee of olden times. Naturally indolent he worked as little as possible, but he was well acquainted with the art of turning others to account and getting them to work for him. In ordinary business he managed with ease, and skilfully skimmed the surface of things, but he did not possess the talent of speaking on the spur of the moment on important emergencies. Probably this defect led him to the adoption of one of his fundamental axioms, never to explain one's self at the moment. He was accustomed to say, what however had been often said long before him, that language had been given to man to enable him to conceal his thoughts. On the occasion of the July Revolution of 1830 he at first kept entirely aloof. Louis Philippe, however, before accepting the throne, asked his advice, and received the short answer that he should take it. When, by the revolutions in Belgium and Poland, in connection with other circumstances, the July throne became endangered, Talleyrand at last came forward, and finally abandoning the old dynasty and his own work united with Louis Phillippe for the maintenance of the peace of Europe. In September 1830 he went as Ambassador to London, and made all kinds of exertions calculated to show off the peaceable intentions of the July dynasty. To him mainly was it owing that Austria and Prussia joined the conferences of the three powers which had decided the fate of Greece, and that after endless protocols the powers united in their views with regard to Belgium. After these results he turned to what had long been his favorite idea, the formation of a combination of France, Britain and Austria against Russia. The plan was partly successful when in 1834 he subscribed the quadruple alliance (the parties to which were France, England, Spain and Portugal), which was intended above all to guard the constitutional principle in Western Europe. He returned from London in 1835, and repeatedly made his appearance at the court of the citizen-king, where he was received with great distinction, and revered by the ladies as an oracle. It is said that before his death he was reconciled with the Church. The principal part of his immense property, estimated at about 18,000,000 francs, he left to his niece, the Duchess of Dino. He left memoirs in manuscript which were to remain unpublished till 30 years after his death. They have proved of little value. Consult 'Correspondence Between Talleyrand and Louis XVIII' (1881); Lamartine, 'Mémoires Politiques'; Blanc, 'Histoire de Dix Ans'; Guizot, 'Mémoires', and Blennerhasset, 'Talleyrand' (1894); McCabe, Jos., 'Talleyrand' (London 1906).

TALLIEN, Jean Lambert, zhŏṅ läṅ-băr ta-lē-ăṅ, French revolutionist: b. Paris, 1769; d. there, 16 Nov. 1820. He first made himself widely known by publishing a revolutionary journal called *Ami du Citoyen*. He soon became one of the most popular men of the revolutionary party, and was concerned in the commotions of 10 Aug. 1792. Nominated a deputy to the Convention from the department of Seine and Oise, he distinguished himself in that body by his violence in the process against Louis XVI, even objecting to the king's being allowed counsel to defend him. He took part in most of the sanguinary proceedings which occurred during the ascendency of Robespierre, and in 1794 was sent on a mission to Bordeaux. Here he was checked in his sanguinary career by the influence of Madame de Fontenay, a woman remarkable for her beauty, who, having been imprisoned at Bordeaux as she was going to join her family in Spain, owed her life to Tallien. He took her with him to Paris, whither he went to defend himself before the Convention against the charge of moderation. After the fall of Danton and his party, Tallien perceived that he should become one of the next victims of Robespierre if he did not strike the first blow. Accordingly, at the sitting of the Convention of the 9th of Thermidor (27 July 1794) he vehemently assailed Robespierre, and it was mainly by his influence that the latter with his friends was brought to the guillotine. At this period he married his *protégée*, Madame de Fontenay. Having been nominated a member of the committee of public safety, he used all his influence against his former associates, Fouquier-Tinville, Carrier, Lebon, etc., and demanded the suppression of all the revolutionary committees. In 1795 he was sent as commissioner of the Convention to the army of Hoche in Brittany. He subsequently became a member of the Council of Five Hundred, but his influence gradually declined. In 1798 he accompanied Bonaparte's Egyptian expedition. The vessel in which he sailed to return to France was captured by the British, and he was taken to London. On finally reaching France he found his importance altogether gone, and was glad to accept the office of French consul at Alicante. The last five years of his life were spent in poverty in Paris.

TALLIS, or TALLYS, Thomas, English composer of cathedral music: b. about 1514; d. 23 Nov. 1585. He was the author of some of the finest chants in the cathedral service of the English Church, and filled the position of organist of the chapel royal in the reigns of Edward VI, Mary and Elizabeth. William Byrd, the distinguished musician, was his pupil, and the two published in 1575 a collection of motets and hymns. Tallis composed settings to the 'Venite Exultemus,' 'Magnificat,' the 'Nunc Dimittis' and other canticles and to the 'Te Deum' as used in the English service, and his works fill a large space in the church music catalogue of Novello.

TALLMADGE, tăl'măj, **Benjamin,** American soldier: b. Setauket, N. Y., 25 Feb. 1754; d. Litchfield, Conn., 7 March 1835. He was graduated from Yale in 1773 and became principal of a high school in Wethersfield, Conn. He enlisted at the outbreak of the Revolution and rapidly attained the rank of major. In 1779 he crossed Long Island Sound and captured 500 Tories at Lloyd's Neck, L. I., and in 1780 successfully planned the capture of Fort George at Oyster Bay. He was given the custody of Major André and had charge of his execution. Later he settled in Litchfield, Conn., and he was member of Congress from 1801–17. Consult 'Memoirs' by his son (1859).

TALLMADGE, Nathaniel Pitcher, American legislator: b. Chatham, N. Y., 8 Feb. 1795; d. Battle Creek, Mich., 2 Nov. 1864. He was graduated (1815) at Union College, then studied law and (1818) was admitted to the bar. He commenced practice at Poughkeepsie, and was sent to the assembly in 1828, serving as State senator from 1830–33, when he was elected to the United States Senate. He was appointed by President Tyler governor of the Territory of Wisconsin in 1844, retiring within a year from office and practising his profession at Fond du Lac. His last years were spent at Battle Creek, Mich.

TALLOW, a somewhat indefinite mixture of the harder and less fusible fats, which is chiefly prepared from the natural fat of sheep and oxen. It consists mainly of stearin, olein, and palmitin, and it is nearly colorless and taste-less when pure, although the commercial product is commonly yellow. Until the cellular tissues are removed it is termed suet. In the manufacture of tallow the animal fats are cut into pieces and boiled with water, the fatty matter then melting and rising to the surface, whence it is removed by skimming. The cellular tissues of the natural fat remain behind, sensibly unaffected; but they are afterward treated by great pressure, to express whatever tallow they may have retained after treatment by the boiling process. The whiter and purer portions of the tallow are used in the manufacture of candles, and the softer and yellower grades are used in the manufacture of soap, as well as for dressing leather, and as a lubricant for heavy machinery. The melting point of tallow varies with the composition of the substance, commonly ranging from 100° F. to 120° F. The specific gravity is usually about 0.93.

TALLOW, Mineral, a waxy solid formed of a mixture of the higher hydrocarbons, usually of the paraffin or methane series. Commonly called ozokerite, earth wax or hatchettite. It may be considered a solid petroleum. It occurs in irregular seams and masses in the earth, in Galicia, in the Caucasus, and in Colorado. After purification it gives a product called ceresine, very similar to beeswax in physical properties. It is used in the manufacture of candles, of insulating materials, of bottles to contain hydrofluoric acid, and as an adulterant for beeswax.

TALLOW TREE, any of several trees which yield rather dense fatty substances used like tallow for making candles and soap. The tallow tree or butter-and-tallow tree of Sierra Leone (*Pentadesma butyracea*) is a member of the family *Guttiferæ;* the oil obtained from its fruit is used like butter. The tallow-tree of Malabar (*Vateria indica*) belongs to the family *Dipterocarpaceæ* and is noted for its large leathery leaves sometimes 10 feet long, its panicles of fragrant white flowers, for the hard, white, scentless tallow of its seeds, and for the «East Indian copal» which is obtained from incisions made in its large trunks. The candle-nut (q.v.) is often called tallow tree. In America the tallow tree of China (*Sapium sebiferum*), a member of the family *Euphorbiaceæ,* is probably best known. It has become naturalized in the Southern States, having been introduced in the vicinity of Charleston and Savannah whence it has extended. It is a large tree with long-stemmed, smooth, ovate pointed leaves, about two inches long; inconspicuous flowers in straight terminal spikes; and hard, smooth, brown three-celled capsules about half an inch in diameter. The hemispherical seeds are covered with a white waxy tallow, and after the capsule bursts, hang by threads among the bright red leaves of autumn. They are gathered by the Chinese, crushed and boiled (the capsules also), and the tallow skimmed off. Wax is often added to increase the consistency, about three pounds to 10 being the usual proportion. For ages this tree has furnished the Chinese with their candles. Vermilion is often added to color the otherwise white wax.

TALLQVIST, tal'kvist, **Knut L.,** Swedish Orientalist: b. Kyrkslätt, 16 March 1865. He studied at the Swedish Normal Lyceum and the University, Helsingfors, then at the universities at Leipzig and Berlin. Student from 1883, he was candidate in philosophy (1887), licentiate (1890) and regular doctor in 1894. He was docent of Assyriology and Semitic languages (1891–99) becoming professor of Oriental literature in the latter year. He wrote ‹Die Sprache der Contracte of Nabunaid› (1890); ‹Babylonische Schenkungsbriefe› (1891); ‹Die assyrische Beschwörrungsserie Maqlû› (1895); ‹Arabische Sprichwörte und Spiele› (1897); ‹Ibn Sa'id Kitab almugrib, Book IV› (1899); ‹Neubabylonisches Namenbuch› (1905).

TALLY, a stick divided longitudinally through the middle, formerly in general use as a medium for recording accounts. One-half was kept by the debtor and one by the creditor, and when any debt or payment was recorded the two halves were adjusted together, and a notch or some other mark made on them both. This method, however inconvenient in other respects, was an excellent security against forgery, since it would be difficult, if not impossible, for a person to make a false tally correspond with the counter-tally, in all respects in which the forger wished them to correspond, so accurately as not to be detected as false. When a debt was entirely cleared off, the creditor's tally was given to the debtor. Tallies were in use till the 18th century for keeping accounts in the exchequer of England. In modern usage any mark made to record a score may be termed a tally. A common method of keeping such a tally, as in counting votes, is to make a stroke for every vote, and draw every fifth stroke across the preceding four, to separate the strokes into groups of five, for easy counting. Such a group of marks is also called a tally.

TALMA, Francois Joseph, frăn-swă zhō-zĕf tăl-mä, French tragedian: b. Paris, 15 Jan. 1763; d. 19 Oct. 1826. In 1787 he made his début at the Theatre Français in the character of Séide in Voltaire's ‹Mahomet› and was received with applause. Talma rendered an important service to the French stage by introducing dressing in accordance with the time and country of the character represented. Chenier's tragedy of Charles IX, or Saint Bartholomew's, was brought forward in 1789, and Talma, after studying the character of Charles in history, and his person in medals and portraits, exhibited them with such truth and life that his reputation as the first French tragedian was established beyond dispute. The principal parts which he created, or carried to the highest perfection, were Séide, Othello, Hamlet, Sylla, Regulus, the grandmaster of the templars, Charles IX, Charles VI, Manlius and Orestes. He did not generally excel in comedy, but appeared in 1823 with great success in the character of Danville in Delavigne's ‹Ecole des Vieillards.› Talma was the great favorite of the Emperor Napoleon and accompanied him to Erfurt in 1808 and to Dresden in 1813. He was the author of a small but very interesting work, entitled ‹Reflections sur Lekain et sur l'Art Théâtral,› and of an autobiography afterward edited and published by Dumas (1849–50).

TALMAGE, James Edward, American geologist and theologian: b. Hungerford, England, 21 Sept. 1862. In 1876 he emigrated to Utah with his parents who had embraced the faith of the Latter-day Saints. He was a student at Lehigh University 1882–83; at Johns Hopkins University 1883–84, and was graduated as B.S. in chemistry from the former in 1891 and received honorary D.Sc. from the same institution in 1912; also honorary D.Sc. and didactics from Church of Jesus Christ of Latter-day Saints 1890. He was professor of chemistry and geology, Brigham Young University 1884–88; president Latter-day Saints University, Salt Lake City 1888–93; president University of Utah 1894–97; professor of geology and mineralogy, University of Utah 1894–1907; consulting and mining geologist 1907–11; director Deseret Museum, Salt Lake City, since 1891. He was one of two delegates from the Royal Society of Edinburgh to International Geological Congress, Russia, 1897. In the Church of Jesus Christ of Latter-day Saints he was ordained deacon 1873, teacher 1877, elder 1880, high priest 1884 and as one of the council of the 12 apostles of the Church 1911. He is a life fellow of American Association for the Advancement of Science; Royal Scottish Geographical Society; Royal Microscopical Society, London; Geological Society, London; Geological Society of America; Royal Society of Edinburgh; life associate of Philosophical Society of Great Britain. He is the author of 'First Book of Nature'; 'Domestic Science'; 'Tables for Blowpipe Determination of Minerals'; 'The Great Salt Lake Present and Past'; 'Account of the Origin of The Book of Mormon'; 'The Articles of Faith'; 'The Story and Philosophy of Mormonism'; 'The Philosophical Basis of Mormonism'; 'The Great Apostasy'; 'The House of the Lord'; 'Jesus the Christ,' etc.

TALMAGE, Thomas De Witt, American Presbyterian clergyman: b. Bound Brook, N. J., 7 Jan. 1832; d. Washington, D. C., 12 April 1902. He was graduated from the New Brunswick Theological Seminary in 1856 and was ordained pastor of the Reformed Dutch Church, Belleville, N. J., in that year. He held Reformed (Dutch) pastorates in Syracuse, N. Y., in 1859–62, and Philadelphia, in 1862–69; was a chaplain in the Union army during the Civil War, and in 1869 became pastor of the Central Presbyterian Church in Brooklyn, N. Y. His congregation erected in 1870 a new church known as the Brooklyn Tabernacle, which was burned in 1872. It was rebuilt in 1874, but twice again was destroyed by fire. After the third fire in 1894 Dr. Talmage resigned his pastorate and traveled abroad. In 1895 he accepted a call as associate pastor of the First Presbyterian Church of Washington, D. C., later becoming full pastor, a charge which he resigned in 1899 in order to devote himself to literary work. He was editor of *The Christian at Work,* New York, in 1873–76, of *The Advance,* Chicago, in 1877–78, of *Frank Leslie's Sunday Magazine* in 1879–89, and of the *Christian Herald,* New York, from 1890. For 30 years his sermons were printed weekly in religious and secular papers, and in 1901 it was estimated that they were published in 3,600 newspapers in various languages. He also appeared weekly for many years as a lyceum lecturer. Among his many publications are 'The Almond Tree in Blossom' (1870); 'The Brooklyn Tabernacle' (1884); 'From the Pyramids to the Acropolis' (1892); 'From Manger to Throne' (1894), etc. Consult Adams, 'Life and Sermons of T. DeWitt Talmage' (1902); Wilkinson, W. C., 'Modern Masters of Pulpit Discourse' (1905).

TALMUD, a code or digest of Jewish laws and opinions. See JEWS AND JUDAISM; THE TALMUD.

TALON, ta'lôn, **Jean Baptiste,** French Canadian administrator: b. Picardy, France, 1625; d. 1691. In 1663 he was made chief officer of justice, police and finance in the French possessions in America. He encouraged trade by building ships and sending exploring parties to Hudsons Bay and the Upper Lakes. Three of his seigniories were erected into baronies and he assumed the title of Count d'Orsainville. His memoirs form a valuable source of information with regard to early Canadian history. Consult Talon, 'Memoire à sa majesté sur l'état present du Canada' (1667).

TALTAL, täl-täl', Chile, a seaport in the province of Antofagasta, situated near the southern boundary of the province. It has railroad connection with the mining regions of the interior, and exports considerable quantities of nitre and some metals. Pop. about 7,000.

TÁLÚK, ta-look', or **TALOUK,** a term applied to land tenure in India, and having different meanings in different parts of the country, but generally describing an estate subject to some control intermediate between the government and the proprietor. The word itself in Arabic signifies dependence, and this indicates the usual sense of the term as applied to land. In Bengal it is an ownership subordinate to the Zemindars, who were originally tax-farmers for native princes, but whom the British authorities in India elevated to a sort of lordship over the property whose taxes they gathered in. In the Northwestern Provinces it is an inferior estate, or part of an estate, paying revenue through a superior proprietor. In Oude and Madras the word means a district set off for revenue purposes, evidently a derivation from the old meaning of an estate held under tax-farmers. One who administers such a district is a talukdar.

TALUS, accumulations of debris at the foot of steep slopes or cliffs. It may be material broken off by frost, by gravity, or by any other agency. It accumulates at the foot of the slope as a result of gravity. These talus slopes or cones are often of enormous size and consist mostly of coarse angular blocks. When cemented together this forms Talus Breccia. See BRECCIA.

TAM O'SHANTER. Composed, it is said, in the course of a single day, 'Tam o'Shanter' was written at Ellisland in 1790, while Burns was struggling with the difficulties of farming and the duties of exciseman. In no other poem does his peculiar genius find fuller expression. Scott said of it: «I verily believe 'Tam o'Shanter' to be inimitable.» Inimitable it is in its imaginative audacity: the vivid realism of the alehouse «bousing»; the weird terrors of Tam's midnight ride; the grim grotesques of the Kirk-Alloway revels, with «auld Nick — a towsie tyke»; the triumphantly serio-comic dénouement. And blent with this fantasy there is the keen, humorous sympathy of his characterizations: of «our sulky, sullen dame, nursing her wrath to keep it warm»; of Souter Johnny, «his ancient, trusty, drouthy crony»; of Tam himself, «the blethering, blustering, drunken blellum.» And as in 'Tam o'Shanter' the imagination of Burns is unmarred by the moralizing and sentimentalizing that so often beset him, so the style, terse, racy, picturesque, illustrates his mastery over his native idiom. Burns himself said of this poem that it «shewed a finishing polish» that he «despaired of ever excelling.» And we may echo his verdict that the unique quality of 'Tam o'Shanter' is one that he never did excel. Consult Henderson, T. F. (in 'Cambridge History of English Literature,' Vol. XI, and bibliography).

FRANCES W. CUTLER.

TAM-SUI, tăm-soo'ē, Formosa, a seaport on the northern coast of the island at the mouth of the Tam-sui River, 10 miles northwest of Tai-pe, the capital. It is the chief export town of the island, and the principal staples are tea, rice, sugar, coal, jute, camphor, etc. Pop. about 7,000.

TAM-TAM, tăm tăm. See TOM-TOM.

TAMA, tä'mạ, Iowa, city in Tama County; on the Iowa River, and on the Chicago, Milwaukee and Saint Paul, and the Chicago and Northwestern railroads, about 63 miles northeast of Des Moines and 18 miles east by south of Marshalltown. It is in an agricultural and stock-raising region. An Indian reservation (Sac and Fox) is nearby. The chief manufacturing establishments are flour mills, paper and lumber mills, broom factories, machine shops and cigar factories. The shipments consist chiefly of flour, brooms, poultry, livestock, eggs, vegetables and grain. There are seven churches, public and parish schools, two banks and a library. Pop. 2,800.

TAMAGNO, Francesco, Italian operatic tenor: b. Turin, 1851; d. Varese, 1905. His début on the operatic stage occurred (1873) in 'Un Ballo in Maschero,' at Palermo. Under Abbey he first appeared on the New York stage in the season 1889–90 when his name in Europe was a word to conjure with among his patrons. Under Abbey and Grau, season 1894–95, he was again on the boards in New York at the Metropolitan Opera House and Americans were treated to his rendering of 'Othello' his greatest rôle, which had made such fame in Milan. He retired from the stage in 1902.

TAMANDUA. See ANT-EATER.

TAMANOIR, the great ant-eater (q.v.).

TAMAQUA, tạ-mä'kwạ, Pa., borough in Schuylkill County, on the Little Schuylkill River, and on the Philadelphia and Reading, and the Central of New Jersey railroads, about 35 miles north of Reading and 15 miles west of Mauch Chunk. It is in a region noted for the quantity and quality of coal deposits. It was settled in 1799, and became a borough in 1833. The chief manufacturing establishments are flour mills, foundries, machine shops, a powder mill and planing mills. It has large coal yards. There are about 70 factories, paying wages of over $300,000 annually, with products of over $1,000,000. There are 12 churches, a high school, elementary schools, a business college and a library. There are several banks and newspapers. Pop. 10,000.

TAMAR, tā'mạr, (1) a southern river of England, flowing between the counties of Cornwall and Devonshire; and emptying through the Hamoaze into Plymouth Sound, two miles above Plymouth; length about 60 miles. (2) A river of Tasmania, formed by the union of the North and South Esk, and flowing into Bass' Straits at Fort Dalrymple.

TAMARACK. See LARCH.

TAMARAO, a sturdily built dwarf buffalo (*Bos mindorensis*) of the Philippines, which stands about three and one-half feet high at the shoulders and has coarse, thick, blackish brown hair. «The horns,» says Lydekker, «although massive, are comparatively short, and rise upward in the plane of the face with a lyrate curvature; they are distinctly triangular, with the largest face in front, and are somewhat roughened. In its massive horns, thick legs and uniform coloration, this species comes nearer to the Indian buffalo than to the anoa.»

TAMARIN. See MARMOSET.

TAMARIND, a leguminous tree (*Tamarindus indica*) and its fruit. It is supposed to have originated in eastern tropical Africa, but is now universally cultivated in the tropics. It reaches a height of 80 feet, and has a crown of widespreading branches and thick foliage. The leaves are abruptly pinnate, the flowers fragrant, red and yellow, with three perfect petals, and four sepals and colored caducous bracts. They are gathered in terminal racemes. The bean-like fruits are indehiscent flattened pods, and have a brittle brown shell. The seeds are flat, angular and shining, and are embedded in a dark-hued fibrous juicy pulp, which is pleasantly acid, laxative and cooling. This fruit is used to prepare tamarind fish, to make acidulous cooling drinks, and is also an article of commerce, with or without being preserved in sugar. Every part of the tree is used for medicinal purposes, except the yellowish-white, purple mottled wood, which is valuable for turnery, being hard and heavy. The seeds are astringent, the leaves are employed for curries and for a yellow or red dye. Velvet, or brown, or black tamarinds, are the product of a small leguminous tree (*Dialium guineense*), of Africa. It has pinnate leaves on slender branches, and downy black pods, of about the size and shape of a hazel-nut, containing seeds embedded in an edible, farinaceous pulp. The tamarind of New South Wales is a slender sapinaceous tree (*Cupania anacardioides*) of Australia, has an acid fruit and coarse-grained, whitish wood. Wild tamarind is a large tree of Jamaica (*Pithecolobium filicifolium*), having twice-pinnate leaves; *Pithecolobium dulce* is the sweet-pulped Manila tamarind. Certain leguminous trees of Central America and the West Indies, *Pentaclethra filamentosa* and *Acacia villosa*, are respectively the wild and the yellow tamarind.

TAMARISK, any member of the genus *Tamarix*, which is represented by shrubs, also called «flowering cypress,» inhabiting warm arid regions, but not hardy in America as far north as Massachusetts. They are salt-loving plants, often growing so near the sea that the spray of high breakers dashes over them, and are.

therefore, admirable for maritime planting. Like some other plants living near salt-water, or on arid steppes, certain species of *Tamarix* bear foliage with a punctate appearance, caused by minute pits. These leaves excrete saline solutions, which in rainless seasons serve to attract moisture during the cool nights, and facilitate its absorption by special cells at the bottom of the tiny cavities. In the daytime, the dried salts cover the leaves with a crust, which protects the plants from excessive evaporation under the desert sun. The tamarisk salt-tree (*T. articulata*) of the Indo-Chinese region is a bush or small tree looking somewhat like a conifer, which secretes enough salt to be useful in a culinary way; it is also the source of tamarisk-galls employed for medicine and for dyeing, since they contain 50 per cent of tannin; also an astringent bark.

Tamarisks are generally planted for ornament but are sometimes killed in hard winters quite to the ground. They are of unusual feathery aspect, with widely spreading, somewhat wand-like branches, crowded with small leaves like scales. In the axils of these are many dormant branch-buds, so that the plant readily sends out new shoots. The flowers are small and pink, in close spike-like racemes which are often panicled, and are softened by the many protruding stamens. One of the most widely known (*T. gallica*) reaches 15 or 20 feet in height, with panicled racemes blooming in late summer; it is very easily propagated and furnishes good fire-wood. A species of the Levant (*T. mannifera*) when punctured by a scale-insect (*Coccus manniferus*) exudes honey-like drops of sap that harden in the morning coolness; this is gathered and sold to Syrian pilgrims as manna (q.v.). The German tamarisk is *Myricaria germanica*. It has wand-like branches, bluish foliage, and many racemes of light pink flowers, terminating lateral branches.

TAMATAVE, tä-mä-täv′, the capital of Madagascar, situated on a peninsula slightly north of the middle of the east coast. It is the principal port of the island and has a good harbor protected by a natural breakwater, and fortifications. A railroad connects it with Antananarivo, which was the capital up to 1902. There is also canal transportation. Hides, gold dust, rice and rafia fibre are the leading articles of export. There is cable communication with Mozambique, Mauritius, Reunion and Aden. There are good banking facilities. Pop. 8,647.

TAMAULIPAS, tä-mow-lē′päs, Mexico, a state on the Gulf coast, occupying the northeastern corner of the country. Its area is about 32,128 square miles. The southwestern part of the state is traversed by the eastern Sierra Madre, but the greater portion belongs to the tertiary coastal plain, and is a rolling country, sloping gradually to the coast. The latter is lined with lagoons and sand-bars. The state is traversed by several large streams, and the Rio Grande forms the northern boundary. The climate on the coast is hot, and the northeastern plains are semi-arid. The population is chiefly centred on the lower mountain slopes, where the rain is sufficient. There are three railway lines. Agriculture and grazing are the chief industries. Cotton, sugar and cattle products are exported. Tampico (q.v.) is the chief seaport, whence steamships connect with Pensacola, Baltimore, New York and Havana. The capital is Ciudad Victoria. Pop. 249,641.

TAMAYO Y BAUS, tą-mą′yō ē bą-oos, **Manuel**, Spanish dramatist: b. Madrid, 1829; d. 1898. His parents were actors and the boy traveled about with them and early learned to play his parts on the stage; and thus early gained an insight into the nature and structure of the drama. The natural result was that he soon began writing dramas himself. His first dramatic production, an adaptation of 'Genevieve de Brabant,' was produced successfully when he was only 11 years of age. In this play his mother and himself took leading parts, the first production taking place in Granada. From this time on he continued to write for the stage and to acquire an increasing reputation as a dramatist. At the age of 29 he was elected a member of the Spanish Royal Academy, and for the last 14 years of his life he was director of the National Library and chief of the board of archivists, librarians and antiquarians. Among his best-known dramas are 'La locura de amor' (1855); 'Lances de honor' (1863); 'Un drama unevo' (1867). The latter, which has been translated into English under the title of 'A New Drama' by J. D. Fitz-Gerald and T. H. Guild (New York 1915) is considered his best drama. Consult Cotarello y Mori, E., 'Historia Literaria' (Vol. I, Madrid 1901); Sicaras y Salvado, N., 'Manuel Tamayo y Baus' (Barcelona 1906); Tonnenberg, Boris de., 'L'Espagne litteraire' (Paris 1903).

TAMBERLIK, tăm-bĕr-lēk′, **Enrico**, Italian operatic singer: b. Rome, Italy, 16 March 1820; d. Paris, 15 March 1889. He began his career at Naples as tenor singer in 1841, and in 1850 went to England, where he enjoyed great popularity for 24 years. He visited the United States in 1857. After his retirement from the stage he lived in Madrid, where he engaged in the manufacture of small arms.

TAMBOBONG, tăm-bō′bŏng, Philippines, pueblo, province of Rizal; in the northwestern part of the province, near the coast of Manila Bay; five miles north of Manila. It has a large sugar refinery and a cigar factory; the weaving of cotton cloth and the fisheries are also important industries. It is connected with Manila by steam tramway, and carries on a considerable trade. Pop. 25,000.

TAMBOUR-WORK, a species of embroidery introduced into Great Britain in the 18th century, now little used. A single tambour worker usually sits at a low circular frame, over the top of which the silk, linen or muslin is stretched by means of a hoop, much in the same way as the head of a drum is tightened. A frame of different construction is used when several workers are employed on the same fabric, consisting principally of two rollers, which, when properly fixed, stretch the linen, etc., to the necessary degree of tension. As the work proceeds the finished part is wound over one roller, while a fresh surface is at the same time unwound from the other. The needle, which is about one-half inch in length, terminates in a small hook with the point curving inward. This is fixed in a handle of bone, ivory or wood, of the thickness of a quill, by means of a small screw on the side. The worker, holding the thread on the under side of the frame, passes the needle through the muslin, etc., from the upper side, and by a continued series of loops interwoven together, succeeds in producing a verv minute and beautiful chain line, with which she traverses the outline of any pattern previously sketched upon the fabric she is employed to ornament.

TAMBOURA, the name applied in Persia and Turkey to a musical instrument of the guitar type, with strings of wire struck with a plectrum. The neck is long and the body, of gourd-shape, is often beautifully ornamented.

TAMBOURINE, tăm-boo-rēn', a musical instrument of the drum type, much used among the Italian peasants and negro minstrels. It consists of a piece of parchment stretched over the top of a broad hoop, which is furnished with little bells. It is sounded by sliding the fingers along the parchment or by striking it with the back of the hand or with the fist, elbow, etc.

TAMBOV, tăm-bŏf', Russia, capital of the government of that name, on the left bank of the Tzna, at the confluence of the Studenetz, 263 miles by rail southeast of Moscow. It was founded in 1636 and was then fortified, and is yet surrounded by a dilapidated rampart, and is built chiefly of wood. It has a gymnasium, military school, ecclesiastical seminary, female institute, house of correction and infirmary; is the residence of a governor, the see of a bishop and the seat of several important courts and public offices. There are breeding studs, manufactures of woolens and sailcloth, leather, soap, tallow, alum and vitriol, and a considerable trade with Moscow and Petrograd in tallow, leather, wool and provisions. Pop. 71,400. The government or province is 25,710 square miles in area and the population (1915) is 3,555,000. It is a rich agricultural region.

TAMERLANE, tăm-ẽr-lān'. See Timur.

TAMIL, or TAMIR, a branch of the Dravidian stock to which the original inhabitants of India belonged. They inhabit the extreme south of India, and have remained comparatively free from admixture with the Sanskrit-speaking Indo-Europeans and other invading races of subsequent arrival. Retaining their own tongue they adopted and developed the civilization of their conquerors and are much more enlightened than other races of Dravidian stock. The Tamil language is spoken over a large section in the extreme south of India; it is spoken to a great extent in Ceylon; it is spoken also by a majority of the Indian settlers in places farther east, as Pegu, Penang, etc.; and in many parts of southern India, even where it is not the vernacular, it is spoken by the better class of Hindus. The structure of the language is very simple. It has two dialects: the higher (Shen-tamil), now used in poetry, is the more ancient of the two; the lower (Kodun-tamil) is the language of common life. The literature of the Tamil language, the earliest extant works of which are supposed to be as old as the 9th century of our era, embraces nearly every branch of the knowledge of northern India. Consult Pope, 'First Lessons in Tamil' (Oxford, 7th ed., 1904). See India.

TAMING OF THE SHREW, The. 'The Taming of the Shrew' has been the most permanently popular of Shakespeare's minor plays and is still notably successful on the stage. There is little agreement regarding either the date at which it was composed or the extent of Shakespeare's concern in it. It was first printed in the 1623 folio, but a separate quarto edition in 1631 shows its continued appeal at a time when few but the very greatest of the Shakespearean plays justified individual republication. This drama is a refashioning of one of the best pre-Shakespearean comedies, 'The Taming of A Shrew,' printed in 1594. The characters are renamed (except Kate) and the lines wholly rewritten, but the general conduct of the plot is not radically altered, more change in the last regard appearing in the story of Bianca than in that of Katharine. Since the effort to ascribe to Shakespeare the original 'Taming of A Shrew' is invalidated by the fact that the former play belonged to Lord Pembroke's company and by its ridiculous purloinings from Marlowe, legitimate speculation is limited to discussion of the extent of the poet's revisionary work in preparing 'The Taming of the Shrew.' That the Katharine-Petruchio scenes were recast by him is agreed, but many critics refer the scenes dealing with the lovers of Bianca to an unknown second reviser. No particular reason for the last assumption exists beyond the unwillingness to credit Shakespeare with work not manifestly beyond the abilities of his contemporaries. This, of course, is a correct criterion only where it is clear that the author is exerting his full power. In the case of the present play it is logical to suppose that the entire revision was done by Shakespeare, who handled the main plot with enthusiasm and retouched the subordinate scenes with independence and adequacy, but in a somewhat perfunctory spirit. The notable Induction, with the character of Sly, is not primarily Shakespeare's contribution; it occurs in the earlier version, where indeed Sly continues on the stage through the entire performance and offers frequent comments like those of Revenge and Andrea's Ghost in 'The Spanish Tragedy.' Shakespeare, apparently in the interests of simplification, allows him to be forgotten after the first scene of Act I, but he has made the Induction peculiarly his own by the insertion of Warwickshire place names and allusions. On 26 Nov. 1633 'The Taming of the Shrew' was acted at Saint James' Palace before Charles I and the queen. It is noted that the play was "liked." Two nights later it was followed by a performance of Fletcher's sequel, 'The Tamer Tamed,' in which Petruchio's second wife turns the tables. Various adaptations of Shakespeare's play were popular in the 17th and 18th centuries. In 1754 Garrick produced a three-act abridgment called 'Katherine and Petruchio,' which for a century or more supplanted the original. The complete play was revived by Augustin Daly in 1887 with deserved success. John Drew played Petruchio, Otis Skinner Lucentio and Ada Rehan Katharine. One hundred performances were given between 18 January and 13 April.

Tucker Brooke.

TAMMANY HALL. See TAMMANY SOCIETY.

TAMMANY SOCIETY, or COLUMBIAN ORDER, The, was founded 12 May 1789 by William Mooney, ex-Revolutionary soldier (two weeks after the national government was established), as «a fraternity of patriots solemnly consecrated to the independence, the popular liberty and the federal union of the country.» It had for its objects (1) the perpetuity of democratic-republican institutions; (2) benevolent care of Revolutionary soldiers and others of its members, «their widows and orphans, and others who may be proper objects of their charity.» The membership was composed of those who were known before the Revolution as «Sons of Liberty» and «Sons of Saint Tammany»; societies formed to promote the cause of independence. The society was opposed to the Saint George, Saint David and Saint Andrew societies, whose Tory members openly proclaimed fealty to George III. After the Revolution, Alexander Hamilton (q.v.) removed the political disabilities of these Tories (1787) and they became the foundation of the Federalist party, and being rich and influential fought corruptly for Hamilton's scheme of a Federal President and Senate, to hold office for life, who should appoint the State governments and dominate Congress. Many of these Loyalist Tories were elevated to office immediately on their enfranchisement. This enraged the «Liberty Boys» who fought England's soldiers, and suffered repeated betrayal by these same Loyalists whose plots were many against the patriots. Many of these Tory conspiracies were successful and sent numbers of patriots to the charnel prison ships to meet death; others failed, as when the Tory mayor of New York, Mathews, plotted to kidnap Washington and assassinate his staff. The hatred bred by these and kindred infamies was fanned to flame by the disfranchisement of Revolutionary soldiers whose means and property were meagre. In 1777 the constitutions drafted and operative in New York State gave the right to vote only to those who owned «freehold to the value of 100 pounds, free of all debts.» This gave full political power to the rich Loyalist Tories who monopolized trade and banking privileges, while it disqualified the bulk of those who fought in the patriot army and those who were punished by poverty for nobly sustaining the Revolutionary cause. The founding of the Society of the Cincinnati (q.v.) augumented the existing bitterness and hatred. Jefferson and others pointed out its menace to the liberties of the people and its monarchial plan to found an order of hereditary nobles, with militarism as a basis. The Tammany Society was founded as a crowning protest to these portentous happenings and to discredit Alexander Hamilton's prophecy that the democratic-republican scheme of government was doomed to disastrous failure.

Early History.—The Tammany Society was divided into 13 tribes corresponding to the 13 original States. The Society adopted Indian titles and ceremonials and the forms and usages of the aborigines to the fullest extent practical. The wigwam was the term applied to the Society's place of meeting. Indian symbols and mottoes were used to designate the 13 tribes, as follows:

The Eagle Tribe, New York State.
The Otter Tribe, New Hampshire.
The Panther Tribe, Massachusetts.
The Beaver Tribe, Rhode Island.
The Bear Tribe. Connecticut.
The Tortoise Tribe, New Jersey.
The Tiger Tribe, Delaware.
The Rattlesnake Tribe, Pennsylvania.
The Fox Tribe. Maryland.
The Deer Tribe, Virginia.
The Buffalo Tribe, North Carolina.
The Raccoon Tribe, South Carolina.
The Wolf Tribe Georgia.

The 13 sachems (or trustees) annually elected a grand sachem or president. The *kitchi okeinaw,* or great grand sachem, was an honorary office conferred upon the following Presidents of the United States: Washington, John Adams, Jefferson, Madison, Monroe, John Quincy Adams and Jackson. The office was abolished after General Jackson's incumbency. The Sagamore was the master of ceremonies and the Wiskinskie the sergeant-at-arms. According to the true Indian fashion the year was divided into seasons and these subdivided into moons. The era began with the discovery of America by Columbus and included the year of the Declaration of Independence and of the founding of the Society. (New York City, 3 Dec. 1903, is written by the Society thus: Manhattan Season of Snows, 12th moon, year of discovery 411th, of Independence 127th and of Institution 114th). The Society motto is «Freedom our Rock.» The following toasts at the 4 July 1789 banquet illustrate the Society's sentiments from its formation. Thirteen cannon shots followed each toast. These are the two first toasts: (1) «May honor, virtue and patriotism ever be the distinguished characteristics of the Sons of Saint Tammany.» (2) «The head men and chiefs of the Grand Council of the Thirteen United Fires — may they convince our foes not only of their courage to lift, prudence to direct, and clemency to withhold the hatchet, but of their power to inflict it in their country's cause.»

Achievements.— The national government repeatedly failed to conclude a treaty of peace with the warlike Creek Indians whom the Federal government was anxious to placate. The Tammany Society undertook the conciliation. The Celtic half-breed chief McGillivray, who led the Creek tribe of Indians, with 28 of his chiefs and warriors were brought to New York by Tammany and given a banquet 2 Aug. 1790. The Tammany braves were in full Indian costume when they escorted McGillivray and his warriors to President Washington. The treaty was signed 13 Aug. 1790. The Society in June 1790 founded a museum for «the preservation, collection, and study of Indian relics, etc.» In 1791 the Society, under the direction of John Pintard, its first sagamore, founded many educational and progressive institutions which later developed great efficiency under the Society's fostering care. Two of these institutions have since merited national recognition, namely, New York Historical Society (q.v.) and the Academy of Design (q.v.). In 1793, when France in desperation struggled to overthrow feudal oppression, the Tammany Society's sympathy and moral support was prompt, enthusiastic and enduring. Sentiments and sympathies of political and other associations were usually expressed by toasts at a banquet specially held for that purpose. Until about 1840 these «public dinners» were the chief means of announcing the policies, booms and sentiments of political and social bodies. On 12 May 1793 the Tammany Society, at its annual dinner, gave the toast, «Success to the Armies of France, and wisdom, concord, and firmness to the Convention.» This was greeted with roars of applause for many minutes. The society suffered a flood of vituperation, abuse and threats of grave harm from the Tories and Federalists. In 1800 the society bought real estate collectively to comply with the property qualifications imposed on the voter. On 13 April 1808 the society marched in a body to Wallabout («Wallabocht») Bay, where the foundation stones were laid by them of the receiving vault, for the bones of 11,600 patriots, victims of England's brutality. The society collected 11 hogsheads of bones along the beach of Wallabout Bay of those who died of hunger, disease and cold in the awful English prison ships. Tammany interred these bones in a tomb near the present navy yard with imposing military and civil ceremonials. In 1812 the Tammany Society loudly called for war with England, pledging «their lives, fortunes and sacred honor» in support of the government for the waging of «that just and necessary war.» At every stage of the conflict the Society gave full and loyal support. Tammany Hall in Nassau street became the headquarters of the war party where they hoisted the flag to proclaim each victory and celebrated the success of the American forces in loyal manner. Tammany also gave a fighting force to the nation, which developed later three able generals and a colonel. In August 1814 about 1,200 members of Tammany Hall went in a body to Brooklyn and erected earthworks and other defenses. On 29 June 1814 members of the Tammany Society mobbed a large Federalist meeting gathered to celebrate the return of the Bourbon dynasty to the throne of France. In 1817 the Society with high patriotic speeches and ceremonial made imposing interment of General Montgomery in Saint Paul's churchyard. On 23 Feb. 1819 Tammany gave a banquet in honor of Gen. Andrew Jackson at which they launched a boom in his behalf for the Presidency.

Manhood Suffrage.— From the moment of its foundation in 1789, the Tammany Society fought for manhood suffrage and against «imprisonment for debt.» On 1 Dec. 1820 a Tammany Hall mass meeting resolved: «That the distinction of the electoral rights; the mode of appointment to office and the union of the judiciary and legislative functions were objectionable and highly pernicious.» The meeting urged the legislature to pass the reform measures they advocated and when the legislature overwhelmingly advocated the extension of the suffrage, Tammany celebrated the victory for reform 14 June 1821, at Tammany Hall with democratic jubilation. The sentiment dominant at this gathering is tersely expressed by one of their members: «We would rather be ruled by a man without an estate than by an estate without a man.»

On 4 March 1822 a banquet was given at Tammany Hall for the purpose of expressing their utmost joy at «the extension of the right of suffrage and the abolition of those cumbersome relics of old centralizing methods, the Council of Appointment and the Council of Revision.» The function of the former was expressed in its title; that of the latter was to give final approval or disapproval of all legislation. The «Toasts» at this banquet appropriately express the Tammany sentiment of the participants. Here are two illustrations: «The right of suffrage — corruption in its exercise most to be apprehended from its limitation to a few.» This was another: «The young and rising politician — may integrity and principle guide him — studying the public good, not popularity.» The extension of the suffrage greatly increased the voting power of Tammany and augmented its political prestige. In 1820 manhood suffrage in full became a fact; Tammany's political power having vastly increased, in this year Tammany succeeded in abolishing the last vestige of property qualification to the right of suffrage by an overwhelmingly large popular vote. In 1826–27 Tammany forced the fight for the five-year limitation for the acquisition of citizenship. In 1827 a Tammany delegation visited General Jackson at New Orleans to present an anniversary address on the famous battle in which he humbled England, and to urge his candidacy for the Presidency in the coming year. Martin Van Buren (who was a member of the Tammany Society) visited New York later in the year and organized the sentiment of the Society for Jackson. To offset this sentiment and the large alien vote of Tammany, the «Native American Party» was formed, whose battle cry was «Political privileges should belong exclusively to the natives of the country.» In 1828 Tammany gave General Jackson nearly 6,000 majority in a total vote of nearly 25,000. This was the first national election held wherein the State of New York chose Presidential electors by popular vote.

Mid-Century History.— On 26 Nov. 1830 Tammany Hall held high festival in honor of the French Revolution. President Monroe, though in feeble health, reviewed the Tammany parade and later presided at the banquet at Tammany Hall. Patriotic speeches for democracy were delivered and elaborate fireworks concluded the celebration. In 1831 Tammany abolished «imprisonment for debt,» where the debtor was a resident by New York City. On 3 March 1831, Tammany, by a unanimous resolution, declared the renomination of General Jackson and the nomination of its Grand Sachem of the Eagle Tribe, Martin Van Buren, for Vice-President. In 1832 Tammany gave General Jackson 5,620 of a majority in a total vote of 30,474, despite the flagrant corruption and frauds openly used to defeat Jackson in this national election. The United States Bank and allied financial interests denounced Jackson as a «Revolutionist,» whose «despotism» would spread throughout the nation «the fearful consequences of anarchy.» The bank officials publicly gave $6 a vote, and as their resources seemed unlimited, raised the bribe in particular cases, yet failed to defeat Jackson. On 13 June 1833 General Jackson exhibited his gratitude to Tammany Hall by a ceremonious visit to the wigwam, accompanied by Governor Marcy, Vice-President Van Buren, the Secretary of State Woodbury and the mayor and common council of the city. In 1833, through Tammany's persistence, sustained by the public opinion which it aroused, the State legislature was forced to pass as a reform measure an act permitting New York City to elect its mayor. In 1834 Tammany Hall for the first time in United States history elected a mayor by popular vote. Tammany's candidate was Cornelius W. Laurence. The United States Bank and the combined money powers of the period bent every energy to defeat Laurence. All the newspapers were subsidized, and alarmed the citizens with inflammatory editorials predicting "Universal disaster," "general destitution," "trade paralysis" and "appalling panic." Agents of the banks hired thugs and bred riots. Serious disorder and daily scenes of violence preceded the election. Every form of coercion was employed on the business element and actual trade suspension was artfully produced. Yet, despite all these artificial and real terrors and their influence on the timid and greedy, Tammany elected her candidate and gave an enduring argument for the spread of manhood suffrage throughout the nation. In June 1861, Grand Sachem William D. Kennedy took to the front a regiment composed of members of Tammany Hall, which had been raised and equipped by the Tammany Society. This regiment, the 42d New York Infantry, distinguished itself for valor in 36 battles and engagements. In 1864 Tammany presented General McClellan's name at the Chicago convention as the Presidential candidate of the Democratic party. General McClellan received, in the ensuing election, from Tammany's efforts, a majority of over 37,600 in a total vote of about 110,000. In 1870 Tweed, having gained an ascendancy in Tammany Hall, committed the organization to many extravagant expenditures, thus bringing much scandal upon the wigwam. He was forced to retire from his leadership and was driven out of the country, a prey to ruin and disgrace. Since that time Tammany has ceased to stand for high policies and has become emblematic of boss rule and policies for "what there is in it."

Later History.— In 1872 the reform of the organization was undertaken by a group of Democrats under the guidance of Samuel J. Tilden. Tammany came to the front again with John Kelly as its leader. It became a factor in city, State and national politics. Under Mr. Kelly, Tammany largely regained the confidence and respect of the Democracy. Upon his death, in 1886, Tammany was governed by a committee consisting of Richard Croker, James J. Martin, Hugh J. Grant and Thomas F. Gilroy. This government eventuated in the absolute leadership of Richard Croker. Under the influence of Mr. Croker, Tammany in 1888 won a series of brilliant political victories, establishing democracy firmly in the city and State. It was due to Mr. Croker's skilful management that all of the so-called Democratic organizations in opposition to Tammany Hall were put out of existence and Tammany left the sole representative of Democracy in this, the greatest city in the United States. In 1900, after the defeat of the Democracy in the country at large, Mr. Croker ceased to take an active interest in Tammany affairs. He resigned his leadership after the municipal defeat in 1892, and the Hon. Lewis Nixon, a protégé of Mr. Croker's, was placed in command. Mr. Nixon's training had been for the navy. His knowledge of politics was purely academic, and his leadership was naturally very brief. The organization then drifted along under the leadership of a committee consisting of Daniel F. McMahon, Louis F. Haffen and Charles F. Murphy. In 1903 Mr. Murphy assumed the leadership upon the vote of the executive committee. Mayor George B. McClellan and the entire Tammany ticket were elected in November 1903.

He was re-elected, and in 1910 William J. Gaynor was elected by Tammany. While Mr. Gaynor was markedly independent, yet Tammany held its grip on most of New York's political activities. In 1913 the fusion candidate, John Purroy Mitchell, beat the Tammany forces, and there was a partial return to Republican rule. However, notwithstanding Mitchell's acknowledged ability and popularity, Tammany beat him in 1917, with an almost unknown candidate, John F. Hylan. Tammany maintains in Manhattan probably the strongest and best organized political machine in the world. While there are Democratic organizations and leaders in the outlying boroughs, they are known to be subservient to Tammany, and the assembly districts all have Tammany leaders — the very name of Democratic organization is lost. Permanent headquarters and leaders exist in each of the 23 assembly districts and subordinates handle the details like a great army. They are in business all the year around and every day in the year, aiming to maintain their hold in all the political offices and all the expenditure of public moneys that they possibly can. The fact that they have been able to place many judges on the bench as well as to control most of the executive offices has at times been the subject of great scandal. Yet membership in the organization includes very many men of high character and patriotism, and their influence at times is apparent.

Tammany for many years has catered to and largely held the votes of the poorer classes — charity has been dispensed widely from the district offices; bureaus are maintained to give work to those who can be depended upon to vote with the organization; excursions, parties and dances are given freely; those who have a bad habit of getting into jail for small offenses are systematically bailed. Notwithstanding that, members and followers have been charged time and again with catering to vice, even discussing it and trafficking in it; with dishonesty and wastefulness of public funds; with placing and keeping incompetents in office, and the entire list of political mistakes, weaknesses and crimes, yet after every exposure and temporary reform, the same old Tammany comes back to power and dominates the politics of the world's largest city. Consult Breen, 'Thirty Years of New York Politics' (1899); Lewis, 'Richard Croker' (1901); Riordon, 'Plunkett of Tammany Hall' (1905); Forrest, J. W., 'Tammany's Treason' (Albany 1913).

TAMMERFORS, tăm'mĕr-fŏrs (Finnish, TAMPERE), Finland, a town in the government of Tavastehus, about 80 miles northeast of Abo, on the railway from the Gulf of Finland to the Gulf of Bothnia. It is the third largest town in Finland, and the principal manufacturing centre. Its industries include cotton and linen spinning and weaving, and the manufacture of paper, iron and steel mills, locomotive works and shipyards. Pop. 45,213.

TAMMUZ, tăm'ŭz, a Babylonian deity, worshipped by Jews who drifted into idolatry, and mentioned in Scripture, in Ezekiel viii, 14: «Then he brought me to the door of the gate of the Lord's house which was toward the north; and, behold, there sat women weeping for Tammuz.» According to Sayce (in Hastings' Dictionary of the Bible) Tammuz was originally the sun-god, and was a Babylonian deity whose worship was early imported into the West, the name being in Sumerian *Dumu-zi*, «the son of life.» In Canaan Tammuz was addressed as Adonai, «my lord,» whence the Greek Adonis; and as Tammuz was originally associated with the Babylonian goddess Istar (Astarte), so Adonis was associated with Aphrodite. The Vulgate agrees with this explanation by its rendering of Tammuz as Adonis. This worship was much practised among the Phœnicians, and was celebrated chiefly at the Phœnician town of Byblus. The ceremonial was prolonged through different scenes. Adonis was supposed to have been killed by a boar; search was made for him, a wooden image being provided to represent Adonis, and on his being found, wild and licentious orgies began, and the burial of the idol terminated the first portion of the pageant. The river of Adonis, or Nahr Ibrahim, at the season of the year at which this worship took place, becomes discolored from the heavy rains on Lebanon, and in the popular superstition the stream was stained by the blood of Adonis.

The resurrection of Adonis next followed in the ritual, and was celebrated with frantic rejoicings. This idolatry appears to have been originally symbolical, connected with the sun's decline in the winter and his returning strength in summer, or with the death of nature and its revival in spring. The festival seems to have been held at the summer solstice. Movers and Hitzig place it at the autumnal equinox; but Tammuz is with the Jews the name of the fourth or midsummer month. Jerome also asserts that the anniversary of the death and resurrection of the fabulous Adonis was celebrated in the month of June. It was, however, in the sixth month that Ezekiel's vision happened. The period of celebration might perhaps vary, or the time of the prophet's vision might not be coincident with the actual celebration of the festival. The worship of Adonis was suppressed by Constantine. Consult Langdon, S., 'Tammuz and Ishtar' (Oxford 1914).

TAMPA, Fla., city, port of entry, county-seat of Hillsborough County, at the mouth of Hillsborough River at its entrance to Tampa Bay, and on the Atlantic Coast Line and Seaboard Line railroads, being the Gulf terminus of both, about 29 miles from the Gulf of Mexico. It has a harbor, the best on the western coast of Florida, and it has regular steamer connection with all the large Gulf ports, large ports of the West Indies and with New York and a number of other Atlantic ports. In the vicinity are large mines of phosphate. Lumber and naval stores are largely produced and shipped.

Manufacturing.— The chief manufacturing industry of Tampa is connected with tobacco products. In 1914 the number of factories was over 200 (three-fourths of them being cigar factories), the capital invested $9,858,000, and the value of the product for the year $14,039,000. The wages paid to workmen are more than $6,500,000 annually. The tobacco used in the factories is nearly all imported from Havana, Cuba. The manufacturing of tobacco in Tampa is largely done by Cuban immigrants. The Sumatra «wrapper leaf» grown in Florida is said to be superior in quality to that grown in Sumatra, and is used to some extent.

Commerce.— The amount of tobacco leaf imported into the port of Tampa from Havana has for several years exceeded that of any other United States port except New York. The internal revenue paid by the city exceeds $1,000,000 annually, and the custom collections for the district are about $9,000,000. Phosphate comes next after tobacco, and over $3,000,000 is sometimes shipped abroad in a single year. The quantity of fruits and vegetables which are being shipped to Northern markets is increasing.

Buildings and Municipal Improvements.— Since 1886, when Tampa was made a port of entry, it has grown rapidly. To accommodate its late number of winter guests, many large and beautiful hotels have been erected. Other fine public buildings are the custom-house, the churches, the schools, the banks and many of the business blocks.

The electric car lines connect the suburban sections with the different parts of the city. The water supply comes from springs; the daily use is 7,000,000 gallons. The pumping capacity of works is 10,000,000 gallons.

Churches, Schools, Etc.— There are 18 church buildings. There are 12 public school buildings, including the Hillsborough County High School, established in 1886. Another high school is in charge of the Sisters of the Holy Name, who conduct three parish schools in Tampa and one in each of the nearby suburbs, West Tampa and Port Tampa. There is a college for boys, under the management of the Society of Jesus, and five private schools. There are three daily and five weekly newspapers. The six banks have a combined capital of $1,000,000, and deposits amounting to over $6,000,000.

Government.— The government is vested in a mayor and a city council, elected by the people for terms of two years. The council has 11 members, three being elected at large. There are police, sanitary and public works departments, including a board of health with ample powers to protect the city's interests.

History.— Tampa is the historical landing place of Narvaez and De Soto, of ill-fated early Spanish expeditions. Its first settlement began with the establishment of the United States military post of Fort Brooke, during the wars with the Seminole Indians. It was the seat of small shipbuilding and salt works during the Civil War, and was captured by Federal gunboats. Its recent rapid growth dates from the coming of railroads and cigar factories in 1886. Pop. (1910) 37,782; (1919) 52,000.

TAMPA, a bay on the west coast of Florida, an inlet of the Gulf of Mexico. The northern part is divided into an eastern arm, Hillsboro Bay, and a western arm, Old Tampa

[illegible]

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TAMPA ...

... on the west coast ... Gulf of Mexico ... into an east ... and a western arm, Old ...

American Scarlet Tanager (Pyranga rubra), with a female (below) and immature males (above)

Bay. The harbor is protected by a line of keys forming barriers against the west winds. A point of land extending south almost closes the inner harbor. The bay is about 35 miles long and from 5 to 15 miles wide. At the entrance, on Egmont Key, lat. 27° 36′ N., long. 82° 45′ 15″ W., is a lighthouse nearly 90 feet in height. This was the landing place of the Spanish explorers De Soto and De Narvaez. On its shore the United States government maintained Fort Brooke for many years previous to the Civil War. During the Spanish-American War this bay was the principal point of embarcation for United States troops to Cuba.

TAMPAN. A poisonous tick found in Angola and other parts of southern Africa. It is about the size of a pea and when filled with blood is dark blue in color. It usually bites the parts between the toes or fingers and causes a disagreeable itching which gradually ascends the limbs till it reaches the abdomen when vomiting or fever occur.

TAMPICO, tăm-pē'kō, Mexico, a town in the state of Tamaulipas, situated in the southeastern corner of the state at the mouth of the Panuco River. It is an old Aztec city, built in a low, unhealthful locality, surrounded by lagoons and marshes. The streets are broad and regular, with large market places, and there are several fine buildings. The harbor has been improved by jetties and a breakwater, and the town rivals Vera Cruz as a commercial port. Its development during recent years is largely due to the finding of petroleum near by. It is the terminus of two railroads, and the commercial outlet for all the Northeastern States, all steamship lines of the vicinity making this port. The exports are petroleum, mining and grazing products, wood, honey, wool and hemp to the total of nearly $100,000,000 annually. The imports are of about one-half this value, being mostly manufactured articles from the United States. Pop. about 36,000.

TAMPICO FIBRE. See Istle.

TAMWORTH, Australia, an inland town of New South Wales, in the northeastern part of the state, on the railroad from Sydney to Brisbane. It is the centre of an agricultural and mining district. Pop. about 7,750.

TAMWORTH, England, a borough of Staffordshire, on the Tarne River, 110 miles northeast of London; the site of interesting old ruins, dating from the 8th century. Pop. 7,500.

TANA, tä'nä, British East Africa, a river rising on the slopes of Mount Kenia, and flowing southeast into the Indian Ocean. It is navigable for light-draught vessels about 350 miles to Hameye, just below the Hargazo Falls.

TANA. See Tree-shrew.

TANA, Lake. See Dembea.

TANAGER, a family of perching birds (*Tanagridæ*), allied to the finches. They are distinguished by the bill being of triangular shape at its base and arched toward its tip. The upper mandible may exhibit a notched appearance; the wings are pointed and of moderate length; the feet short and slender. The hinder toe is strong and elongated, all the digits being provided with strong curved claws. These birds are chiefly found in the tropical parts of America and include several genera and many species, all of brilliant coloration and usually capable of fine singing. One of the best known is the organist tanager (*Euphonia musica*) of the West Indies, so named from the pleasing and varied nature of the song. The Antilles possess several peculiar species. Three or four species of the genus *Pyranga* are regular migrants to the United States in summer, one, the scarlet tanager, or black-winged fire-bird (*P. rubra*), being familiar at that season throughout all the Northern and Eastern States and southern Canada. It is of less size than the robin, and a bird of the woods and orchards rather than of open lands, and almost never seen upon the ground. The male is everywhere rich scarlet except his wings and tail which are pure black. This full plumage is not acquired, however, until the fourth year, the young males being dull yellow, more or less reddened according to age; while the females are always clothed in an inconspicuous dress of mottled green. The song of the male is loud, vigorous and merry, and is heard later in the summer than that of most other birds. The nest is a rather rude structure placed in a tree, and containing greenish, brown-spotted eggs. In the Southern States another species, the summer redbird (*P. æstiva*) is of more pinkish and glowing hue than the scarlet tanager, and lacks the black on wings and tail; it has a Western variety (*Cooperi*). The males of another Western species, the Louisiana tanager (*P. ludoviciana*) are yellow and black, with the head red; and a fourth darker species (*P. hepatica*) is mainly Mexican. Consult Ridgway, ‹Birds of North and Middle America,› Part II, (Washington 1902), and standard books on American birds.

TANAGRA, tăn'a-gra, Greece, an ancient town of Bœotia, on the left bank of the Asopos, 15 miles east of Thebes, the scene of a battle in 455 B.C. between the Athenians and the Spartans, in which the latter were victorious. Tanagra, now called Gremada, is a scene of ruins. Excavations since 1873 have brought many interesting objects to light, especially the beautiful painted terra cotta draped female figures from six to nine inches in height, known as Tanagra figurines.

TANANARIVO, tä-nȧ-nä-rē'vō. Capital of the island of Madagascar. Its most prominent building is the royal palace which is located at the top of a hill. The place has no commerce but has a few industries and many new buildings, among which are two cathedrals, a mosque, several colleges and hospitals and a number of churches. Pop. about 95,000.

TANARO, tä-nä'rō, a river of Italy known anciently as Tanarus. It rises in the Ligurian Alps, in northwestern Italy, flows northeast past Asti and Alessandria, and empties into the Po 10 miles northeast of Alessandria; length 125 miles.

TANAUAN, tä-nä'wän, Philippines, (1) Pueblo, province of Batangas, Luzon, in the northeastern part of the province, 24 miles north of Batangas. It is on the main road to Manila, and was wiped out by a volcanic eruption of Taal, in 1754, but rebuilt. It is the centre of sugar and tobacco raising and fruit growing country, and has large markets. There are good schools. Pop. 20,040. (2) Pueblo, province of Leyte, on the northeastern coast, on

San Pedro and San Pablo Bay, nine miles south of Tacloban. It is on the coast road. Pop. 18,510.

TANCHEL, or TANQUELIN, a fanatic who arose in the Netherlands about 1115, who proclaimed himself Son of God, and had many followers. He was killed at Antwerp in 1125 and those who believed in him, known as Tanchelmians, or Tanquelinians, were converted back to the Roman Catholic faith.

TANCRED, tăng'krĕd, soldier and Crusader: b. about 1068; d. 5 Dec. 1112. His father was a Sicilian or Italian marquis named Odo or Ottobonus; his mother the sister of the celebrated Norman, Robert Guiscard, whose eldest son, Bohemond, was the friend and brother-in-arms of Tancred. (See GUISCARD). In 1096 the two heroes embarked for Epirus, and thence marched to Macedonia. At the siege of Nicæa (1097) Tancred first appears among the heroes who directed the course of events, and he also took a conspicuous part in the battle of Dorylæum (July 1097). He now advanced, with Godfrey's brother Baldwin, over the Taurus toward Jerusalem. Tancred first pentrated through the passes of the mountains, and obtained possession of Tarsus by capitulation. The perfidious conduct of Baldwin caused a quarrel between him and Tancred, but it terminated in the reconciliation of the chiefs, who now joined the main army which was then marching upon Antioch. On the march to Jerusalem, Tancred had command of the advance guard, and he was the first to storm the walls of the town. During the scenes of horror which attended the capture of Jerusalem (July 1099) he conducted himself with humanity. The Sultan of Egypt advanced to attempt the recovery of Jerusalem, but was totally defeated by Godfrey of Bouillon and Tancred before Ascalon (12 August). Tancred captured Tiberias, besieged Jaffa and, after the death of Godfrey, endeavored to effect the election of Bohemond as king of Jerusalem; but the unworthy Baldwin obtained the throne. Tancred subsequently conducted the defense of Antioch, and after Bohemond's death in 1111 obtained that principality. He is represented by Tasso in the 'Jerusalem Delivered' as a brilliant and blameless hero. He is also celebrated in Rossini's opera 'Tancredi' (1813). Consult Guizot, 'Collection des Memoires-Gesta Tancredi'; Delabarre, 'Histoire de Tancrède' (1822).

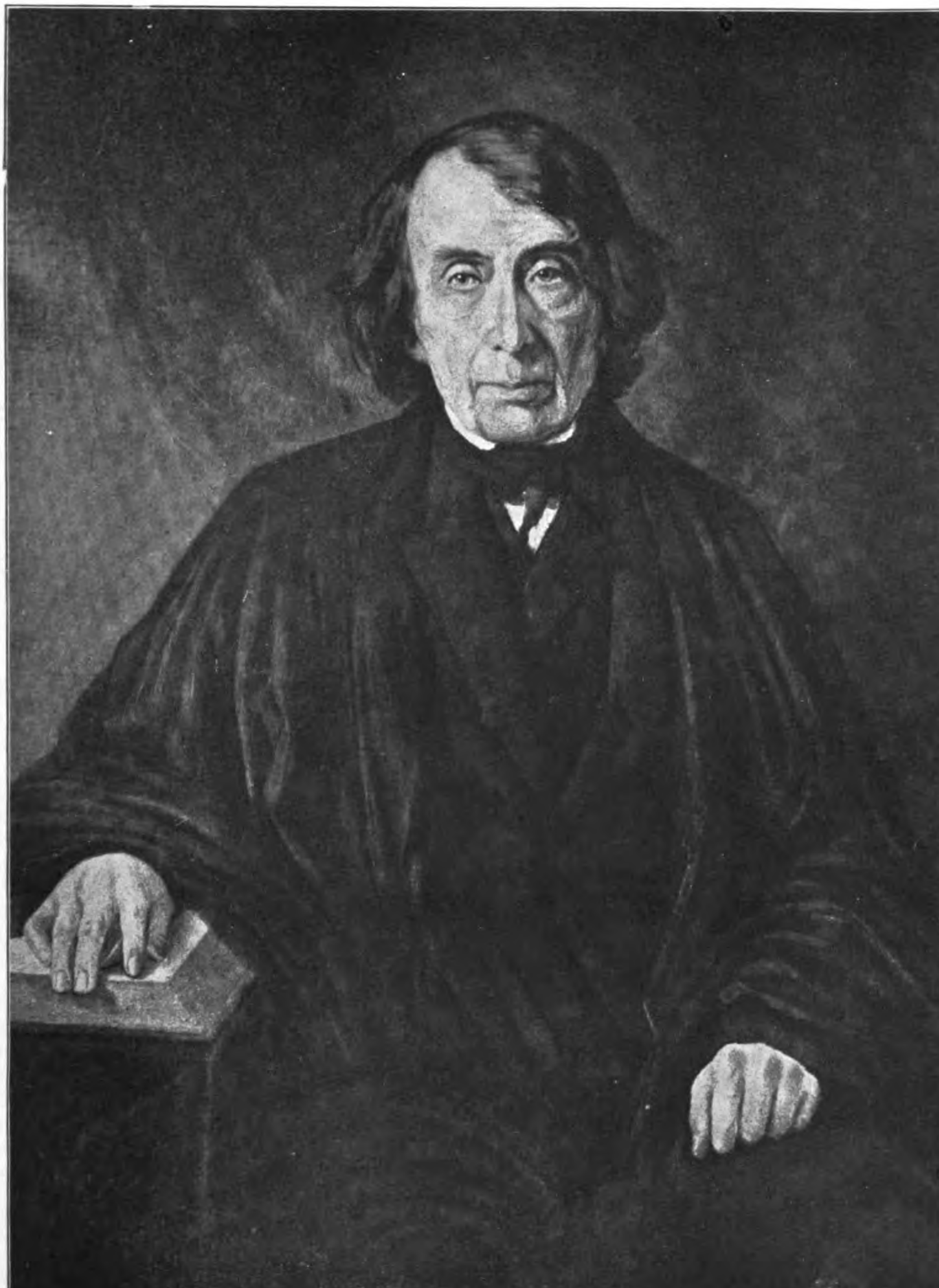
TANDOLANOS, tăn-dō-lä'nōs, a wild Philippine tribe of Malay origin living on the west coast of Palawan, between Punta Diente and Punta Tularan.

TANDUBATO, tăn-doo-bä-tō', Philippines, one of the smaller islands of the Tawi Tawi group, of the Sulu Archipelago, lying off the northeast coast of the island of Tawi Tawi; length, north and south, six miles; greatest width, five miles. The island is mountainous, Tandubato peak being the highest point. See TAWI TAWI.

TANDY, James Napper, Irish patriot: b. 1740; d. Bordeaux, France, 1803. As a Protestant leader of the popular movement he took zealous action in corporation politics, free trade agitation and volunteering affairs, and was elected the first secretary to the United Irishmen of Dublin. In 1792 he sent a challenge to the solicitor-general, Toler, and was condemned to prison till the close of the session by the House of Commons. As the viceroy had offered a reward for his arrest, he raised a formal action for illegality against him and his privy-councillors, which was dismissed at the final hearing. For distributing in County Louth a seditious pamphlet, he was about to be tried in 1793, when the government discovered that he had met the Defenders and taken their oath, with the view of effecting a coalition between them and the United Irishmen. Tandy fled to the United States, but crossed to France in 1798, where he was raised to the rank of a general of division in the French army. He joined the ill-fated invasion of Ireland, and made a futile landing at Rutland Island 16 Sept. 1798. He escaped to Hamburg, the senate of which city handed him over to the English government. On 12 Feb. 1800, he was put on trial at Dublin, and acquitted. He was again put on trial (1801) for the treasonable landing on Rutland Island. This time he was sentenced to death, but, from motives of policy, was permitted to make his way to France, where he spent the rest of his days. He was the hero of the familiar Irish song, 'The Wearing of the Green.'

TANJEFF, Serge Ivanovitch, Russian composer: b. 1856; d. Petrograd, 20 June 1915. He was son of a Russian government official and, while quite young, was studying the pianoforte at Moscow Conservatory under Lange. He was next sent to the public school but later it was decided to continue his music studies under Nicholas Rubinstein. He studied fugue under Hubert, leaving the conservatory (1875) with the award of the first gold medal. He played in Paris 1877–78, then performed through the Baltic provinces, next returning to Moscow, where he was appointed professor of instrumentation, succeeding Tschaikowsky (q.v.). On Rubinstein's death he became professor of the pianoforte but displayed his talents rarely before the public. He composed 'Oresteia' a trilogy in eight acts (1895); 'John of Damascus,' a cantata (1884), many choruses, some symphonies and quartets. He arranged for the piano works of Tschaikowsky, Glazounoff, Arinsky and others.

TANEY, tâ-nĭ, **Roger Brooke,** American jurist: b. Calvert County, Md., 17 March 1777; d. Washington, D. C., 12 Oct. 1864. He was descended from a leading Roman Catholic family, was graduated in 1795 from Dickinson College, read law in Annapolis, began practice in 1799 and was immediately elected to the house of delegates as a Federalist. Defeated in 1801 and again in 1803, he returned to the practice of law. He was married in 1806 to Anne Phœbe Charlton Key, a Protestant, the sister of Francis Scott Key. Though a Federalist, he supported the government during the War of 1812 and was an unsuccessful candidate for Congress. In 1816 he was elected to the State senate. From 1815 to 1831 as one of Maryland's leading lawyers he was engaged in many of the important cases that came before the United States Supreme Court. After the break up of his party, he became a Democrat. In 1827 he was attorney-general of Maryland; and in 1831 was appointed Attorney-General of the United States and was the trusted adviser of Jackson.



ROGER BROOKE TANEY

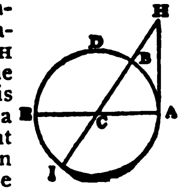
Chief Justice of the United States Supreme Court, 1836-1864

During the Bank controversy the Secretary of the Treasury refusing to remove the government deposits from the United States Bank, Taney, who had advised the removal, was transferred (1833) to the office of Secretary of the Treasury. He then removed the deposits and for this was fiercely criticised as being a «tool» of Jackson, the Senate in 1834 refusing to confirm his nomination, the first instance of the rejection of a Cabinet officer. In 1835 Jackson nominated him for associate justice of the Supreme Court, but again the Senate refused to confirm. In 1836 the personnel of the Senate having changed, Taney was nominated and confirmed as chief justice to succeed John Marshall, but not without strong opposition from Henry Clay and others. Taney at once showed tendencies toward strict construction and reversed several of Marshall's decisions. This angered the associate justices, some of whom threatened to resign. Taney was a strict constructionist rather than a States rights lawyer and judge. In the case of Prigg v. Pennsylvania the chief justice for the first time declared a State law unconstitutional. This was one of the «personal liberty» laws. In 1850, a similar law of Wisconsin was declared invalid. These decisions of the Supreme Court called forth States rights expressions from Northern legislatures. Taney's best-known decision was made in the Dred Scott case. The only point really decided was that Dred Scott was a slave, but the opinion of the court written by Taney also declared: (1) that negroes had not been regarded as citizens by the framers of the Constitution and hence could not become citizens of the United States nor have a standing in Federal courts; (2) that the Missouri Compromise was unconstitutional because Congress was bound to protect property, and the Constitution having recognized slaves as property, Congress was bound to protect slavery in the Territories. During the Civil War the Supreme Court ceased to have influence. Taney in the Merryman case (1861) denied the power of the President to suspend the writ of habeas corpus, and during the next three years opposed with no effect the arbitrary methods of the administration. As a lawyer, Taney never avoided the unpopular side. In 1811 he made himself disliked by defending Gen. James Wilkinson. In 1819 he defended a Northern Methodist minister indicted for inciting slaves to insurrection. During the trial of this case he said: «A hard necessity compels us to endure the evil of slavery for a time; yet while it continues it is a blot on our national character.» He emancipated his slaves, providing for their welfare. As chief justice, he brought system into the procedure of the Supreme Court which it had lacked under Marshall. Weak sight and bad health made writing difficult for him and the opinions of the court were usually written by one of his ambitious associates. He retained his mental powers to the last, in spite of wretched health. In person he was tall and thin, with an appearance of great physical weakness; in disposition quite, cheerful and studious, devoted to his family and friends. Consult Van Santvoord, 'Sketches of the Lives and Judicial Services of the Chief Justice of the United States' (1853); Tyler, S., 'Memoir of Roger Brooke Taney' (1876). Taney wrote an autobiography, which ended with 1801 and forms chapter I of Tyler's Memoir.

WALTER L. FLEMING,
Professor of History, West Virginia University.

TANGANYIKA, tä-gän-yē'kä, central Africa, a large lake on the boundary between the Kongo Free State and what was German East Africa, touching with its southern extremity on British Rhodesia. It lies in the Great Rift Valley, is over 400 miles long, 30 miles wide, and extends in a south-southeast direction from lat. 3° 20′ to 8° 44′ S. The shores are somewhat irregular but there are few islands or reefs. The lake is hemmed in on both sides by lofty, precipitous mountains, through a break in which the water is discharged by the Lukuga into the Kongo, when the water is high, but in low years there is little or no discharge. Nearly all the surface is navigable, and soundings at some points have gone below 2,000 feet. The sudden storms of the locality are, however, a real danger to navigation. The water is slightly brackish and swarms with fish, crocodiles and hippopotami and some marine mollusks, whose presence suggests former connection with the ocean. English and German steamers ply on the lake; Ujiji is the principal trading station on the shores. The lake was discovered by Speke and Burton in 1858, and later explored by Livingstone and Stanley. It was mapped by E. C. Hore about 1880, and the outline considerably corrected by later explorers. The first steamship was the *Good News*, launched by the Londan Missionary Society in 1884, and a half dozen now ply the waters. Consult Burton and Speke, Livingstone and Stanley's works; Hore, E. C., 'Lake Tanganyika' (London 1892); Moore, J. E. S., 'The Tanganyika Problem' (London 1903); files of the *Geographical Journal*, and 'Proceedings of the Zoological Society' (London 1906).

TANGENT, a straight line of indefinite length, which touches but does not cut a curve; also the length of a straight line which touches a curve measured from the point of tangency to the point where it meets a diameter of the curve; one of the trigonometrical functions. Tangent to a curve is the limiting position of a secant. Suppose a straight line as cutting a curve in two points near to one another, and then suppose the line to move so that the points approach each other; at the instant when the points coincide the line is a tangent to the curve. Let A B be any arc less than 90°, draw A H touching the arc at A; from the centre C draw C B H, cutting A H in H; the length A H is the tangent of the arc A B. It is now considered best to make a distinction between the tangent of an arc and the tangent of an angle. An arc is a curved line of certain length; an angle is not measured by the length of arc, for the measure of a certain angle is so many degrees, whatever may be the length in inches of the circular arc subtending it. The tangent of an angle is called a trigonometrical ratio, because it is the fraction formed by dividing the number representing the length of one side of a right-angled triangle by that repre-



Tangent.

senting the length of the other side. Consider the triangle H C A, the tangent of the angle H C A is $\frac{AH}{CA}$; this fraction is the same whatever the lengths of A H and C A. (See TRIGONOMETRY). A plane is said to be tangent to a curved surface when three points of the plane coincide with three points very close together of the surface. A list of the properties involving tangents may be obtained from works on analytical geometry.

TANGHIN, a poison yielded by the seeds of *Cerbera* (*Tanghimia*) *veneniferà*, a tree of Madagascar, which is itself called tanghin. The oblanceolate smooth leaves are crowded at the ends of the branches, whence spring also cymes of small flowers. The smooth, roundish, yellow fruits contain a fibrous nut, enclosing a poisonous kernel about the size of an almond. This was employed as an ordeal nut by the natives of Madagascar, to detect witch-craft, or to determine whether or not an accused person were innocent. The seed was pounded and administered to him; if it acted as an emetic, his innocence was established, and no great harm ensued; if he retained the poison he died quickly — a sufficient evidence of his guilt. It has been said, however, that the issue was arranged beforehand, and a strong emetic was given to the suspected criminal not doomed to death.

TANGIER, tăn-jēr', or **TANJA**, tăn'jä, Morocco, a seaport town on the Atlantic Ocean, near the western entrance of the Strait of Gibraltar, southeast of Cape Spartel. It stands on a height near a spacious bay, and presents a striking appearance when approached from the sea. It is surrounded by walls, and is defended by a castle and several forts; but consists mostly of wretched houses, huddled together in narrow, dirty lanes. The residences of the European consuls, and those of a few wealthy merchants are exceptions, and the gradual introduction of good hotels, European stores, electric lighting, etc., is effecting a notable change. The principal building is the castle, occupying a commanding height, but in a very dilapidated state. The total value of the imports, chiefly from Great Britain, France (and before the war Austria and Germany), in 1914 was $4,260,000; of the exports, $2,825,000, chiefly to Spain, Great Britain, Egypt, France and the United States. The principal articles of export are eggs, oxen, slippers, wax, woolens, goat skins and carpets. The internal traffic is chiefly with Tetuan and Fez. In the time of the Roman Empire, Tangier, under the name of Tingis, was the capital of western Mauretania. It afterward came into the possession of the Vandals, Byzantines and Arabs in succession. From the last it was taken by the Portuguese in 1471, and in 1662 was annexed to the English Crown as part of the dowry of the Infanta of Portugal. In 1684 it was abandoned by the English on account of the expense necessary to keep it up. It was bombarded by the Spaniards in 1790, and by the French in 1844. Pop. estimated at 40,000, including over 9,000 Jews, and about 10,000 Europeans.

TANGIER, a sandy island of Virginia about five miles long, in Chesapeake Bay, southeast of the mouth of the Potomac River. Tangier Sound, which washes the north shore, is noted for its large oyster beds.

TANGLEWOOD TALES, a volume of juvenile stories published by Hawthorne (1853). The narrations are based on Greek mythology and are told by a certain Eustace Bright, the supposed narrator of the stories in Hawthorne's 'Wonder Book.'

TANGUAY, tăn'gä, **Cyprien**, Canadian clergyman and genealogist: b. Quebec, 1819; d. 1902. He was graduated (1839) at Quebec Seminary and ordained to the Catholic Church in 1843. In 1860 he founded Rimouski College and the Notre Dame Convent at Saint Germain. He was appointed (1867) by the Canadian government to make researches in Paris as to Canadian history, and again, in 1887, to search Europe's archives for Canadian data. He was one of the earliest Fellows of the Royal Society of Canada. He compiled 'Dictionnaire généalogique, des familles canadiennes' (1871–90, 7 vols.); 'Le répertoire du clergé canadien par ordre chronologique' (1893, 2d ed.).

TANHAY, tän-hī', town, province of Negros Oriental, on the Tanhay River, about two miles inland from its mouth, 15 miles north of Dumaguete. It is near the south entrance to Tañon Strait, and on the coast road. Pop. 12,410.

TANIS, tā'nĭs (Hebrew, ZOAN), ancient Egyptian city, south of the Delta, before the founding of Alexandria, the chief commercial city of Egypt, capital of the Hyksos kings about 2100 B.C., and of Rameses II and Mereneptah of the 19th dynasty, who built there a great temple to Set, the god of war. It was a great city for probably 2,000 years, but its prosperity was destroyed by the silting up of the Tanitic mouth of the Nile, which was named from it, and it was destroyed for rebellion in 174 A.D. The filling up of the delta has resulted in its being left far inland, so there was no inducement to rebuild it. Numerous excavations have been made of the ruins and 14 obelisks in all were uncovered, as well as enormous temples and much statuary. Tanis has been identified with Zoan, mentioned in Numbers xiii, 22, and also with Rameses. The ruins near the fishing village on San el Hager, near the south shore of the Lake of Manzaleh, were explored first by Mariette in 1860, and in 1883–84 by Flinders Petrie (q.v.). Consult Petrie, 'Tanis' (1885); Breasted, J. H., 'Ancient Records of Egypt' (1907).

TANJORE, tăn-jōr', India, capital of the district of the same name, in Madras, on the Cauvery, about 45 miles from the sea and 170 miles southwest of Madras. It is a junction station on the Great Southern Railway of India. The fortified town, about four miles in circuit, contains the palace of the rajah, numerous pagodas and irregular streets. Outside of it are other quarters, an English church, the British residency and a remarkable pagoda, with a tower 200 feet in height and a sculptured bull, which is one of the triumphs of Hindu art. Tanjore is an educational centre renowned for Sanskrit literature, and has a college, three high schools, a medical school, etc. Manufactures of silk muslin and cotton are carried on to a considerable extent. The town was besieged and taken by the British in 1773. It was afterward restored to the rajah, from one of whose successors it was acquired by treaty in 1799. Pop. 60,341. (2) The district of Tanjore has an area of 3,654 square miles and a population about 2,400,000. It is fertile and is regarded as the granary of the Madras territories. It is for the most part covered with rice-grounds, with cocoanut groves interspersed. It is noted for its good roads. Hindu institutions still prevail here in great perfection.

TANK. An engine of war first used by the British in their attack on the Somme (France) 15 Sept. 1916. It was invented by Maj.-Gen. E. D. Swinton, of the British army, using the propelling principle of the «caterpillar» farm tractor, invented about 1900 by Benjamin Holt, of Stockton, Cal. It was afterward adopted in various forms by French, United States and German armies. Essentially a motor-driven armored vehicle, carrying machine guns or other light pieces, it is capable of traversing muddy ground, trenches, shell craters, etc., and making its way over obstacles such as trees, parapets and débris of buildings. The tank is a land battleship for the protection of attacking troops. Like the ancient Roman testudo, or tortoise, it was invented to overcome the great firing power of defending forces, themselves sheltered from infantry fire. The German general staff had learned the defensive value of the machine gun as demonstrated at Port Arthur and elsewhere during the Russo-Japanese War and had not only accumulated thousands of these weapons but had great numbers ot trained units to handle them. During the first years of the war machine guns, both on attack and defense, proved tremendously destructive to the Allies, and as action settled down into trench warfare their effectiveness was even increased. Hidden underground during the artillery preparation for an attack, they could be brought out at the last moment to take an enormous toll in lives. Major-General E. D. Swinton, of the Royal Engineers, and later of the British War Cabinet, was the famous «Eye-witness» of the early months of the war, officially commissioned to report daily fighting for the press and public. This position gave him exceptional opportunity for observation all along the western front. The «caterpillar» tractor used by the British army for towing huge guns over difficult fields suggested to him the idea of a self-propelled fort heavy enough to withstand all but the heaviest-calibred enemy fire and yet mobile under the worst conditions. During the course of a visit paid Mr. Holt by General Swinton in 1918, the tank inventor told the story: «In July 1914 a friend of mine, a mining engineer, was looking for a cheap system of transportation. He wrote me and said, 'I struck a Yankee machine in Antwerp that they call a Holt caterpillar tractor. This machine climbs like hell.' I had known of soldiers wanting just such a machine ever since the time of Julius Cæsar. I thought, if this tractor climbs *like* hell, what we want is something that will climb to *beat* hell. At the beginning of the war I had a peculiar position, with a knowledge of the needs and the chance of discovering many new things. One thing was that the Germans had secretly armed themselves with thousands of machine guns. The machine gun is the most perfect man-killing gun ever made. The Germans manufactured it in England under a British royalty. For a time before the war broke out they did not pay any royalties or submit any accounts. They knew the war was coming and they started it with 50,000 of these guns ready. They used them like artists. Our men went out against them and were mowed down by thousands.

«It appeared that the idea I had in July 1914 might produce a machine that *would* climb, which was absolutely right. It was obvious that launching assaults on enemy positions unless they were first blown to dust was merely to throw infantry into a maze of barbed wire in which they would be caught helpless, like flies on 'tanglefoot,' and mown down by rifle or machine-gun fire poured in at short range from all directions. We had to have something to go across trenches and over barbed wire.

«The machine gun was proving a disease against humanity. It was invented by the late Hiram Maxim, so you Americans have the credit of producing that disease. But you have the credit of producing the antidote, too — the 'caterpillar' tractor, invented by Benjamin Holt. We started out to make that climbing machine, the machine-gun destroyer. We made a large number of them between August 1916 and March 1917, and kept it a secret. It had been whispered around that they were reservoirs to take water to our troops in Egypt. 'Reservoirs' was good camouflage, but it was a long word, and 'tank' was better. The name stuck. They were a surprise to the Germans. They have taken thousands of prisoners and have saved thousands of lives. Frederick Palmer, the American war correspondent, estimated that they saved 20,000 lives on the Somme and as many more at Cambrai, in 1917. Not only have the tanks saved life by the moral effect of their approach and by the number of machine guns put out of action — they themselves have taken thousands of lives.»

The tanks owe their success to two essentials, first, the internal combustion engine, which has also made feasible the use in war of the airplane, submarine and motorized artillery, and, second, the traction or propelling device developed by Holt and established throughout the world as a commercial success without definite forethought as to its application in war. The main features of this mechanism are a track on either side of the machine, composed of a series of steel shoes suitably linked together, with joints protected from mud and dust; idler pulleys for laying the shoes down in front and driving sprockets for picking them up again in the rear; and uprights on the inner surface of the shoes to form continuous rail-like bands upon which roll the truck wheels carrying the weight of the machine. «Caterpillar» and tank have this much in common, that they lay down their own rails and roll over them. Aside from that their purpose and construction are quite different. The tractor is a towing machine, used in war for the rapid, certain handling of guns and supplies, not completely armored and not intended for trench-line duty. The war tractor is practically a mere duplicate of those used on thousands of farms and industrial locations throughout the world. The British, Russian, French and American armies, however, adopted it as the one feasible means of moving heavy mobile artillery over difficult ground, and over a decade of commercial and military experience together perfected the traction mechanism to the point of making the tank possible. The great weight of the machine is distributed over a long and fairly broad surface resting on the ground, hence the pressure of a 12-ton tractor on the soil is actually less per square inch than that of an ordinary man's shoe, a matter of three to six pounds per square inch. Not only is the effect of weight reduced, but the large area in contact with the ground develops enormous useful friction, or ground-grip, which is intensified usually by corrugations on the shoes or by removable lugs or grouters. The first British tanks, viewed from the side, were rather diamond-shaped, the extreme front being the height of a man off the ground. Since the track belts run lengthwise clear around the body, this shape brings additional track surface into contact with the ground during the ascent from a shell crater or ditch. The earliest type is about 34 feet long, 12 feet wide and 10 feet high, and weighs around 32 to 35 tons. A sleeve-valve motor of 120 horse power furnishes power for a road speed up to seven or eight miles per hour. Close-fitting armor sufficient to turn anything except a direct hit from a big shell protects everything but the track itself. The «male» tanks are equipped with light, quick-firing guns capable of firing shell and are essentially destroyers of machine guns. The «female» carries machine guns only, and is used entirely against enemy personnel. Guns are usually mounted front and rear, but barbettes on the sides of the tank give the widest range of aim to the battery amidships. All available wall space is packed with pigeonholes for ammunition. Six to eight men usually form the crew, an engineer, mechanician, two steersmen and two to four men at the guns, one of whom may be the tank commander. Separate clutches drive the two sides of the track, and steering is done by disengaging the clutch on that side toward which it is desired to turn. The other belt then tends to turn the tank about on a pivot. The tank is grotesque in its movements, lumbering along with little outward show of motion; poking its nose suddenly down into a deep crater and as suddenly rearing upright as it climbs a bank or parapet; wallowing through the mud; tipping at apparently perilous angles; climbing over or through ruined walls, smashing trees, or flattening out machine-gun nests. The noise within the tank is terrific and the heat stifling. The huge shape forms a target which is almost irresistible and draws a hail of bullets which would prove more effective against attacking troops. The tanks were first used on the Somme in a surprise attack at dawn — one without artillery preparation. Their success was instant and complete and their dramatic appearance not only proved the sensation of the war up to that time but gave tremendous encouragement to the Allied forces. A similar attack at Cambrai in May 1917 gave the British forces a crushing victory, which, however, was turned into a severe defeat through no fault of the Tank Corps. The French army adopted in 1917 a tank of quite different type, mounting an armored body on what was virtually the conventional tractor propelling mechanism, only considerably longer than that of the «caterpillar» itself. This type gave better protection to the track than the British machine, and mounted even heavier guns. During the spring of 1918 the British scored another surprise in the form of smaller and very fast tanks, called «whippets,» after the breed of racing dogs. These little terrors attacked like the cavalry of past wars, outrunning and cutting down the fleeing enemy, charging machine gun emplacements, twisting and turning with all the agility of a polo pony and clearing the way for the troops behind. The French followed with even smaller machines, known as the Renault Type, manned by two men each and traveling 10 to 12 miles per hour. A large number of these were built in American factories.

The Germans produced some large tanks, rather copying the French type than the British, but had achieved indifferent success up to the summer of 1918, when the offensive passed to the Allies. Bombs placed in their path were found an easy means of overturning them and putting them out of commission. Captured German tanks were lacking in mechanical refinement, proving that Allied initiative in the matter of tanks carried with it a superiority of inestimable value. The Allied tanks probably did more than any other single factor to offset the advantage in man power and centralized command held by the Central Powers during the second and third years of the war. The engineers who perfected the «caterpillar» as a tractor for the American farmer and industrial user, notably Pliny E. Holt, William Turnbull and E. P. Norelius, together with the resources of the plants which supplied thousands of Holt tractors to the British and French artillery divisions, were placed at the disposal of the United States War Department after America entered the fight. The tractor in Antwerp that «climbed like hell» was only the beginning of a remarkable development that proved to be one of America's great mechanical strokes toward the winning of the war. See TRACTOR, CATERPILLAR.

TANKAGE. Fertilizer produced from the offal of the abattoirs. Waste material such as tendons, intestines, lungs, hair, trimmings of hides, bones, horns, hoofs and some blood are the chief component parts of tankage. Hair and hide trimmings are now barred because they are practically indestructible and retain their form in the soil for years. It is treated with superheated steam under pressure to remove fat and gelatine, then mixed with a little slaked lime to prevent rapid fermentation. It is then dried and crushed. If little or no bone is present the product is termed meat tankage. Tankage varies considerably in its composition, sometimes containing as much as 12 per cent nitrogen in meat tankage and in bone tankage up to 9 per cent nitrogen with 7 per cent phosphoric acid. Tankage is a slow-acting excellent fertilizer; in bone tankage its value as a direct crop-producer is dependent largely on the fineness of the grinding. Of course the nitrogen acts in exactly the same manner on the soil as meat. Comparatively tankage contains less nitrogen than dried blood but more phosphoric acid. The considerable variation in its composition is exposed by the following table, taken from Snyder's 'Soils and Fertilizers,' all from one factory:

	1st Year	2d Year	3d Year
Moisture per cent	10.5	9.8	10.9
Nitrogen " "	5.7	7.6	6.4
Phosphoric Acid " "	12.2	10.6	11.7

In a general way 5 to 8 per cent of nitrogen can be expected and from 5 to 12 per cent phosphoric acid. In its action on the soil it is slower than dried blood. It is an excellent garden fertilizer and is also used for field crops in proper rotation and as a top-screening for sod land. As tankage in its full strength should not be allowed to come in contact with seed it is usually applied several days before planting operations, or else a special fertilizer and seed drill is used which places it near but not in contact with the seed. Two hundred and fifty pounds per acre is computed as a good dressing, but as high as 400 pounds can be safely applied under certain conditions. In dry weather an excessive application (say 800 pounds) will destroy vegetation. Of course the strength of fertilizer advisable must be calculated according to the composition of the soil; where the soil is badly impoverished a larger proportion of tankage can be usefully applied than on one kept up in good quality. Because of its comparatively slow action tankage should be used in as finely ground condition as possible and should be applied to the soil with a view to its permanent benefit rather than as a direct food for a certain crop. Tankage of a certain type and content is also utilized as a hog-feed with good results when mixed with corn or other food rich in carbohydrates or fats but poor in protein content. It is also used for feeding dairy-cows and in preparing beef cattle for market. See FERTILIZERS; LIVE STOCK, THE FEEDING OF.

TANNAHILL, tăn'ạ-hĭl, **Robert,** Scottish song writer: b. Paisley, 3 June 1774; d. there, 17 May 1810. He received little education, having been apprenticed to a weaver at an early age, and wrote some of his songs while working at the loom. In 1802 he made the acquaintance of Robert Archibald Smith, a Scottish composer, who set a number of his songs to music. In 1807 he published the first edition of his 'Poems and Songs'; a second edition being declined by the publisher, Tannahill became despondent and drowned himself. In 1838 appeared a complete collection of his writings, with a memoir by Ramsay.

TANNER, tăn'ẽr, **Benjamin Tucker,** African Methodist bishop: b. Pittsburgh, Pa., 25 Dec. 1835. He was educated at Avery College, Allegheny, Pa., and at Western Theological Seminary. He was editor of the *Christian Recorder* for 16 years, founded and was for four years editor of the A. M. E. *Church Review,* and in 1888 was appointed bishop. He was a delegate to the third Ecumenical Methodist Conference held in London in 1901, and has published 'The Origin of the Negro' (1869); 'The Negro in Holy Writ'; 'The Color of Solomon — What?,' etc.

TANNER, Henry Ossawa, American artist, son of B. T. Tanner (q.v.): b. Pittsburgh, Pa., 21 June 1859. He studied under Thomas Eakins at the Pennsylvania Academy of Fine Arts subsequently removing to Paris he became the pupil of Jean Paul Laurens and Benjamin Constant. In the Salon of 1896 he received honorable mention and a third class medal in 1897. He was awarded the Walter Lippincott Prize, Philadelphia, in 1900; Second Medal, Paris Exposition, in the same year; and medals at the Buffalo, Saint Louis and San Francisco expositions. He is represented by paintings in the Luxembourg, the Wilstach Collection, and at the Pennsylvania Academy of Fine Arts, Philadelphia.

TANNER, James, American lawyer and public official: b. Richmondville, N. Y., 4 April 1844. He enlisted in the 87th New York volunteers and was soon promoted its corporal. Losing both legs in the second battle of Bull Run, he returned to New York, studied law, and was admitted to the bar in 1869. He received an appointment at the New York custom house and became deputy collector. From 1877–85 he was tax collector of Brooklyn and in 1889 was appointed United States commissioner of pensions, but later resigned to become a pension attorney, prosecuting claims against the government 1889–1904. On 1 April 1904 he was appointed register of wills, District of Columbia by President Roosevelt. From 1876 he was deputy-commander of the Grand Army of the Republic, New York, and 1905–06, commander-in-chief.

TANNER, John Riley, American soldier and statesman: b. Warwick County, Ind., 4 April 1844; d. Springfield, Ill., 23 May 1901. He enlisted in the 98th Illinois volunteers in 1863, and was with Sherman's army during its active campaign in Georgia, Tennessee and Alabama. Returning to Illinois after the war, he engaged in farming and selling fruit trees, entered politics in 1870, as Republican candidate for sheriff, was elected, and held thereafter the offices of circuit clerk 1872–76, State senator 1880–83, United States marshal 1883–85, State treasurer 1886–88, assistant United States treasurer, Chicago, 1892–93 governor of Illinois 1896–1900. He was the recognized leader of the Republican party in Illinois, was the first in Illinois to speak openly for a single gold standard, declaring himself thereon early in 1895, and as governor his administration was able, efficient and economical. Immediately after the blowing up of the *Maine* in Havana Harbor, he secured the passage of resolutions in the legislature, tendering to the national government the material and moral support of Illinois in the event of war with Spain, and within 36 hours after the call for troops he had mobilized 10,000 men at Springfield, thus procuring for Illinois the honor of having the first regiment ready for muster into the national service. His vigorous stand against the importation of contract labor under arms at the time of the Virden riots brought about a storm of protests that his acts were without precedent and unconstitutional. These were met with the answer that he would make precedents and construe the Constitution and the law for the welfare of the State.

TANNHAUSER, tän'hoi-zẽr, German minnesinger, probably of Salzburg or Bavaria, who in the 13th century appears at the court of Frederick the Warlike and other princes. He led a wandering and adventurous life, and taking Neidhart (q.v.) as his model, celebrated in song the loves of the Bavarian peasantry. A didactic poem 'Hofzucht' (Court Behavior) is also attributed to him. He is credited with the original tale of Tannhäuser the knight. This chivalrous knight in the course of his wanderings meets a sage named Hilario, who instructs him in secret lore. At the same city a lady called Lisaura conceives a violent passion for him which he returns. Gradually, however, the tales of his instructor regarding spiritual beings lead him to desire association with some beautiful spirit in mortal form. Hilario assures him that he may attain this at Venusberg, a hill near Freiburg, where Venus holds her court in the midst of all delights. Tannhäuser starts for the haunt of the goddess, on hearing of which Lisaura kills herself. For a long time the knight remains in Venusberg, but at last his conscience touches him, he thinks with regret of Lisaura, and listens to the Virgin Mary, who calls upon him to return. The goddess allows him to depart, when he proceeds to Rome to seek from Pope Urban absolution for his sins. The Pope, however, declares to him that it is as impossible for him to obtain the grace of God, as it is for the staff which he holds in his hand to bud and bring forth green leaves. Despairing, the knight retires and enters the Venusberg once more. Meanwhile the Pope's staff has actually begun to sprout, and Urban, taking this as a sign from God that there is still an opportunity of pardon and salvation for the knight, hastily sends messengers into all lands to seek for him. But Tannhäuser is no longer to be found, and never again appears on earth. The Tannhäuser legend has frequently received poetic treatment, and Richard Wagner has adopted it (with modifications) as the subject of one of his operas. Consult Zander, 'Die Tannhäusersage und der Minnesinger Tannhäuser' (1858); Baring-Gould, 'Popular Myths of the Middle Ages.'

TANNING, broadly speaking, the art of converting the skins of animals into leather. The skin of most of the higher animals consists from the tanner's point of view of two layers, the outer containing coloring matter, the roots of the hair or fur, and being cellular in structure; the inner being thicker and of fibrous structure. The outer layer is decomposed much more easily than the inner by the action of alkalis; the latter is only soluble in water after protracted boiling, yielding a solution which gelatinizes upon cooling. Moist skin undergoes putrefaction when exposed to the air for some time. Dried skin is hard and brittle. In preparing leather the object of the tanner is, in the first place, to remove the outer layer of the skin together with all adhering hair, and, in the second place, to bring about such a change in the under layer as shall prevent it from putrefying in moist air, and at the same time render it indifferent to moisture, without, however, altering its tenacity and suppleness. The process of tanning, therefore, divides itself into two parts: (1) Cleansing the skin and removing the outer layer; (2) converting the inner layer into leather. Technically only the second part of this process merits the title of tanning. As supplementary to these there is involved the process of dressing and currying the leather. The skins used by the tanner are principally those of cattle; but the skins of horses, asses, pigs, goats, dogs, alligators and many other animals are also converted into leather. The quality of the hide varies in different species of animals, and also in the same species, depending upon the quality and amount of the food consumed, and to a still greater degree upon the vicissitudes of climate in which they are reared. Wild cattle are said to furnish hides superior to those of domestic cattle.

In the first stage of the process the skins, having been thoroughly washed and trimmed of tails, shanks and pates are soaked in water until they are sufficiently soft to allow of the adhering flesh and muscle being scraped off by means of a blunt knife; this softening process is generally aided by beating the hides with hammers or sticks worked by machinery. It is of great importance that the water be soft, or if necessary softened with borax. If the hides are green, 24 hours are allowed for the first soaking, and an equal period for a second soaking in a fresh bath. They are usually halved lengthwise between the two soakings. Dry hides are soaked 24 hours in water containing sodium sulphide, then halved and run through a dry mill for nearly an hour and then stacked up in piles for another 24 hours. They are then put back into the same bath for 24 hours more, again milled, then fleshed and put into clean, cold water overnight. If the soaking is too prolonged the skin cannot be made into good leather. The hides are now generally placed in pits with milk of lime, whereby the hair and upper layer of skin is gradually loosened. This operation requires about six days, the hides being changed daily to a fresh lime bath. They are then again subjected to the action of the dressing knife. The final process preparatory to tanning consists in bating the hides in a very dilute acid liquid in which a mild putrefactive fermentatation is going on. This bath is commonly made with lactic acid and glucose, the latter furnishing the fermentative ingredient. In this bath, which continues for six days, the lime is entirely removed and the hides are considerably softened and swollen. The prepared hides may now be tanned — that is, enabled to withstand putrefaction without loss of suppleness — by the action of different materials. These materials may be broadly grouped as (1) tannin, (2) metallic salts, (3) oily matters. When tannin is used the process is always called tanning. When metallic salts are used the process is in some localities called tawing; and when oily matters are used, shamoying or oil-tawing.

Vegetable Tanning.— The sources of tannin used in the vegetable tanning processes are chiefly oak bark and hemlock bark. The former is taken from the yellow and red oaks, though all oaks carry a proportion of tannin which may be available in some circumstances. The tannin content of the best oak bark ranges from 9 to 14 per cent. Hemlock bark is in much larger supply, and, therefore, is more largely used. It carries from 7 to 8 per cent of tannin. Chestnut wood is used to a considerable extent in the South, and an extract of this wood is marketed in other parts of the country showing a tannin content of from 28 to 32 per cent. The quebracho wood of South America is one of the largest sources of tannin, the dry wood yielding 18 to 24 per cent. The extract of quebracho, the form in which it is generally marketed, carries from 62 to 65 per cent of tannin. Other important sources are: Sicilian sumac, with 25 to 30 per cent tannin; gambier, a dry extract of the plant, with 60 per cent tannin; myrabolans — the dried fruit of a tree of India — with 30 to 38 per cent tannin; Mexican mangrove bark, 30 per cent, and African mangrove bark, 40 per cent tannin; valonia — the acorn cups of an Asia Minor oak — 30 to 40 per cent tannin; and palmetto extract, from the roots of the palmetto tree, about 20 per cent tannin. The amount of tanning materials which the United States normally imports is shown by the figures for the fiscal year ended 30 June 1916 — before the entry of the United States into the war caused a dearth of merchant shipping. In that year the amount of quebracho was 106,864 tons, valued at $1,598,465; of mangrove bark was 21,186 tons, valued at $582,992; and of all other tanning materials and extracts, a value of $668,166. The annual consumption of domestic tanning materials is about 900,000 tons of hemlock bark, 400,000 tons of oak bark and 500,000 cords of chestnut wood.

Leather tanned with oak bark or its extract is of a light fawn color, regarded as the most desirable. Hemlock produces a reddish leather; quebracho a yellowish tint; chestnut, a brown color; and mangrove a still deeper brown. Hemlock is rarely used alone, being too harsh; it is commonly combined with quebracho, with which it yields a fine, soft and pliable product of superior color. Quebracho and palmetto are used together to advantage in both quality and color of the leather. A highly approved process combines hemlock, chestnut and quebracho extracts for a primary tanning, and quebracho and gambier in combination for retanning. This formula is particularly suitable for large and heavy hides. All hemlock-tanned leather is improved by retanning with gambier, or gambier and sumac combined. Chestnut tannings are much improved by retanning with sumac. Thick and heavy hides are usually tanned «in the bark» as it is termed; thinner hides «in liquor.» In the former process a layer of spent bark is spread upon the bottom of a wood-lined pit, upon this are piled successive layers of hides and fresh bark, the whole is covered with spent bark and the pit is filled with water. After 8 to 10 weeks the hides are removed to a second tank containing less bark, from which, after three to four months, they are again removed to a third tank containing a yet smaller quantity of bark, where they remain for four to five mouths. If necessary the process is repeated several times. The hides increase in weight from 10 to 12 per cent during this process. The total quantity of bark required averages six times the weight of the dry hides. Tanning «in liquor» consists in placing the hides successively in solutions of tannin of gradually increasing strength. The tannin is thus caused to penetrate the hides completely. The thinner hides must be immersed for 6 or 8 weeks, the thicker for 12 or 24 weeks in the tanning liquor. A more rapid process is obtained by combining the tanning agents. A liquor compound with quebracho extract and palmetto extract is one of the quickest, and the leather may be pressed and split and the grains retanned after 18 to 20 days. The modern tanner divides his work into three stages: in the first the hides are colored by immersion for 24 hours in a weak liquor, activated by one part of hemlock to two parts of quebracho; in the second stage the tanning process is carried forward by strenghtening the liquor by fresh additions twice daily until it tests 30° (barkometer); the third stage follows the pressing to remove superfluous liquor and the splitting of the hide into grains, and is a retanning process with a strong gambier and sumac liquor; for about one hour. The entire process may be completed within eight days.

Mineral Tanning.— This process depends upon the action of chromic acid instead of tannic acid. Of very recent introduction the chrome process has extensively displaced the much slower tannic acid processes and its product seems equally durable and acceptable in the industries. After the hides are bated and washed they are pickled with sulphuric acid and salt or with aluminum sulphate and salt. They are then put into a solution of salt in a vat with paddles, and the paddles run for half an hour. The chrome liquor, a compound of potassium bichromate and sulphuric or muriatic acid, is then added until the bath reaches 50° B., the paddles being run for one hour. More of the chrome liquor is then added, and the paddles run for three hours longer. The remainder of the chrome is then added and the hides left until the tanning is complete, which will take about six hours. They are left in the liquor for 12 hours longer and then pressed and placed in a second bath of sulphurous acid and finally washed with a solution of borax, when they are ready for splitting and retanning with gambier or palmetto. This is the process commonly employed in making calfskin, goatskin and sheepskin leathers, though they are often tanned with alum. In the latter case, when the skins have been washed and prepared by being submitted to processes closely resembling those already described they are separately soaked in a tepid bath containing alum and common salt dissolved in water; they are then, without being dried, placed in heaps for a few days, after which they are wrung out and dried slowly by exposure to air. The alum bath for 10 skins is usually prepared by dissolving 0.70 kilos of alum and 0.30 kilos of common salt in 22.5 litres of boiling water. Aluminium chloride is produced by the mutual action of the salt and alum, and is absorbed largely by the skins; the excess of salt appears also to aid in the conversion of the skins into leather. The tawed and dried skins are softened by being damped and stretched between a curved iron and a movable steel plate, after which they are again dried. Heavy hides are sometimes tawed for the use of the saddler by steeping them in a bath containing a larger quantity of alum and salt than that mentioned above, drying them and then rubbing them with tallow before a charcoal fire. A very strong leather may thus be prepared in a comparatively short time. The more delicate kinds of leather — especially that for making kid gloves, kid shoes, etc., are tawed by immersion in a bath containing alum, salt, yolk of eggs, wheaten flour and water. The oil contained in the egg yolks confers upon the leather a great degree of softness, the gluten of the flour seems to aid the skin in the absorption of aluminium chloride. The skins are stretched by hand and rapidly dried in the open air; they are then damped, placed between linen cloths and trodden upon until they become soft. They are finally polished by rubbing with a glass disc smeared with white of egg or a solution of gum, etc.

Oil tawing.— So called wash leather or chamois leather is prepared from the skins of deer, sheep, calves, etc., by tawing them with oil. The skins having been washed, limed, etc., in the ordinary way, are repeatedly rubbed with animal oil, exposed to the beaters of a fulling machine, and dried. The oil employed is turkey red oil, made by treating castor oil with sulphuric acid. Other oils have been employed, but castor oil remains the only oil which has been successfully sulphonated. A small quantity of carbolic acid is sometimes added. The skins are stretched and sprinkled with oil, which is gently rubbed in with the hand; they are then placed in bundles in the fulling machine and exposed to the action of the beaters for several hours. After exposure to the air the skins are again rubbed with oil and again placed under the beaters; these processes are repeated until the fleshy odor of the original skin is no longer perceptible. By exposure to a warm atmosphere a process of gentle fermentation is originated within the skins, whereby the pores are dilated and the oil is enabled to penetrate the mass more thoroughly. The excess of oil is finally removed by washing with a dilute warm caustic lye; the skins are then dried and dressed. Wash-leather is much used for making military belts, gloves, socks, etc., for surgical applications, for cleaning glass and porcelain and for polishing jewelry. A great variety of other processes are in use for tanning, many of them being patented. These formulas call for such ingredients as witch hazel, horse chestnut, poke-root, crane's bill, blackberry roots, persimmon bark, nicotin, formic aldehyde, sodium nitrate, chromium chloride, iron sulphate, zinc sulphate, etc. For specific purposes these may have their uses, but the basic processes of tanning have remained unchanged for many years.

The manner in which tanning is conducted in different establishment varies much in detail, though the general principles are the same. Instead of that uniformity in the commoner processes which might be expected from accurate knowledge, each tanner treasures his secret as to the best process for bringing about the chemical transformation which it is their common object to effect; and these secret methods, the value of which as the result of a limited experience is inevitably overestimated by those whose knowledge is confined to that experience, prevent comparison and the rejection of superfluous and perhaps injurious operations. The trade of tanning may, however, be said to be still in its infancy, and it must be admitted that the chemical processes involved are far from being solved. It was only at the end of the 18th century that scientific methods began to be applied to leather-making, and although not much progress has hitherto been made, considerable activity has been shown in the pursuit of improvement. The extreme slowness of the process of leather making by any of the ordinary processes of tanning has afforded a strong motive for inquiry as to the possibility of hastening it by additional contrivances. Much time has been saved by splitting the leather as it comes from the lime pits, and tanning the thinner splits individually. The necessity of preserving the solidity and tenacity of unsplit hides seems to militate against any rapid method of progress in the passage of the tanning agents through and through them.

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TANNINS, or TANNIC ACIDS, are compounds of high molecular weight, widely distributed in the vegetable kingdom. Some varieties are found in diseased vegetable tissues or in abnormal growths, while others are present in the different parts of the healthy plant. Gallotannic acid is present in gall-nuts, caffetannic acid in coffee beans, morringa-tannin in yellow wood, quercitannic acid in oak-bark, ellagitannic acid in pomegranate rind, etc. These tannins are not by any means identical in all their physical properties and their chemical conduct; still they possess some characteristics in common. They are usually amorphous, have an astringent taste, dissolve in hot water, convert animal hide into leather and yield dark-blue or green precipitates with ferric salts. Of these varieties gallotannic acid — the chief constituent of the commercial product — has, more than any other tannin, received the attention of investigators. The statements in this article refer chiefly to this compound.

Gallotannic acid is extracted from powdered galls by treatment with aqueous or alcoholic ether. On standing the liquid separates into an upper layer containing gallic acid and other impurities and into a lower layer, from which crude tannic acid is obtained by spontaneous evaporation. From this product impurities may be further removed by treatment with dry ether in which the acid is insoluble. Ethyl acetate and acetone have also been used quite extensively for the extraction and purification of tannic acid. The compound has further been purified by treating its water solution or suspension with lead acetate. This reagent precipitates a lead salt which is readily decomposed with hydrogen sulphide.

Gallotannic acid is an amorphous substance with an astringent taste, soluble in water, ordinary alcohol, glycerine, ethyl acetate and acetone; almost insoluble in dry ether, chloroform, benzene, carbon bisulphide and petroleum benzine. Its aqueous solution gives an acid reaction with litmus, although its acidity cannot be determined by direct titration, an indicator being practically valueless. With pure *ferrous* salts aqueous solutions of tannic acid give no coloration at first, but a color is soon developed by atmospheric oxidation and a blue-black precipitate is ultimately formed. With *ferric* salts a bluish-black precipitate is at once formed; this reaction is taken as a basis for the use of the compound in the preparation of blue-black inks. Cold alkaline solutions of tannic acid absorb atmospheric oxygen very readily, forming highly-colored oxidation products. Tannic acid solutions form precipitates with many metallic salts, with a number of mineral acids, with nearly all alkaloids and glucosides and with gelatin, albumin and starch. Animal hide kept in a solution of the acid is gradually converted into leather. At 215° C. tannic acid decomposes into water, carbon dioxide, pyrogallol and metagallic acid and with boiling dilute sulphuric acid it is hydrolysed into gallic acid.

Tannic acid is extensively employed in the process of tanning, in the manufacture of gallic and pyrogallic acids, in the preparation of inks and as a mordant in dyeing. With formaldehyde it forms a condensation product which is used in the manufacture of hygienic fabrics. Tannic acid has also found extensive application in medicine. It is recommended as an antidote to metallic poisons with which it usually forms insoluble precipitates. It is employed as an astringent to prevent excessive secretion in ulcers and sores and to check bleeding. Tannigen (tannyl triacetate), tannocol (gelatin tannate), tannalbin and bismuth tannate have been prepared and employed in intestinal catarrh. Mercurous tannate has been used in syphilis, tannochrom in skin diseases, tannobromine in the treatment of scalp diseases.

Although oak-bark, gall-nuts and other natural sources of tannic acid had been used by the ancients, the compound was first isolated and described by Scheele in 1787. Berzilius (1827) assigned to it the formula $C_{18}H_{18}O_{12}$. Liebig (1834) modified this to $C_{18}H_{16}O_{12}$. In 1850 Mulder called attention to the hydrolysis of the compound into gallic acid. Strecker (1852) claimed that tannic acid was a glucoside in which three molecules of gallic acid combined with one molecule of glucose; while others up to the present day have contended that the purified substance contains no sugar. In 1870 Schiff claimed to have converted gallic acid into tannic acid by a process of condensation. He called his product digallic acid and assigned to it the formula $C_{14}H_{10}O_9$, which had also been adopted by some earlier investigators. Schiff's digallic acid formula remained unquestioned for many years, but in 1890 Ph. van Tieghem, C. Scheibler and others made the observation that tannic acid was optically active, a property that rendered Schiff's digallic acid formula improbable. After several years of study Nierenstein (1908) announced the conviction that tannic acid was a mixture of Schiff's digallic acid and optically active leucotannin. While Emil Fischer's researches with the carefully purified substance pointed to the conclusion that tannic acid might be considered as a compound of one molecule of glucose with 10 molecules of gallic acid. The hydrolysis of the compound into glucose and gallic acid, as well as its synthesis, are cited as possible confirmations of this view. At the same time it is frankly admitted that the question of structure has not received its final settlement.

Of late years compounds showing the properties of tannic acid have been prepared by synthetic processes. Of these so-called «Syntans,» Neradol and Neradol D deserve mention. They are obtained by heating phenol sulphonic acids with formaldehyde. It is claimed that the amount of Neradol required to tan skin is less than of any other vegetable tannin.

V. S. Babasinian,
Lehigh University.

TANOAN, tä'nō-ăn, or **TAHÁNO, FAMILY**, a linguistic stock of American Indians inhabiting a group of pueblo villages in the upper Rio Grande Valley, New Mexico. The chief of the modern villages are Isleta, Jemez, Picuris, Pojoaque, San Ildefonso, San Juan, Sandia, Santa Clara and Taos. They are considered the most representative pueblo group, and are probably the most ancient of the pueblo settlements. The villagers who number about 3,000 have not perceptibly advanced in civilization, from the descriptions given of them by Spanish explorers who first visited the villages over three centuries ago. Deriving their name from Tahano, the Indian name of the chief Tano pueblo, they then inhabited a number of other villages, now in ruins, in Mexico, Texas and Arizona grouped under the names Tano, Tewa, Tigua and Piro. Consult Bandelier, H. F. A., 'The Indians of the Southwestern United States, 1880–85' (Boston 1890–92).

TAÑON, tä-ñōn', a strait in the Philippine Islands between Cebu on the east and Negros on the west; the northern entrance is 20 miles wide and the southern entrance five miles; the length is 103 miles. The shores are steep and generally free from obstructions; there are a number of important towns on its coasts.

TANREC, or **TENREC**, a genus (*Centetes*) of insectivorous mammals, distinguished by the elongated muzzle and the short rounded ears. The body is covered on the upper surface with spines and bristles; no tail exists. These animals inhabit Madagascar, the most familiar species being the *centetes ecaudatus*, while other species are the tendrac or spiny tanrec (*C. spinosus*) and the banded tanrec (*C. madagascariensis*). The *C. ecaudatus* is an animal of about the size of the European hedgehog, but with a larger body, the legs being also more elongated. The quills or spines are yellowish at their bases and black toward the tips. These animals hibernate like the European hedgehogs and live in burrows, which they excavate by means of their strong claws. They do not, however, possess the power of rolling themselves up into a ball-like form for defense. The food consists of insects, reptiles, etc. All three species are eaten by the natives of Madagascar.

TANSY, a composite herb (*Tanacetum vulgare*), introduced into America from the northern Old World. It is a familiar weed of waste lands and roadsides, probably escaped from old herb gardens and maintaining its station with vigor — a characteristic which is said to have suggested the Greek name *Athanasia*, «immortality,» which has been corrupted into «tansy.» It is a handsome plant, with dark-green, deeply cleft and pinnatifid, fern-like leaves, numerous on an erect stem about three feet high, which is topped by somewhat dense corymbs of flat, button-like, gold-colored heads of rayless florets. It has a rank odor and bitter, aromatic flavor, which caused it to be used formerly as a seasoning herb, a practice now practically obsolete. The acid juice contains a volatile oil that is very poisonous, yet tansy was a popular anthelmintic and stomachic drug and still holds a place in materia medica as an aromatic bitter and irritant narcotic; it is employed to relieve the pain of ulcers, bruises and rheumatism. White tansy is the sneezewort, and several other plants of similar aspect are also called tansy; while *Argentina anserina* is the goose-tansy.

TANTA, or **TANTAH**, tän'tä, Egypt, capital of the province of Gharbîeh, in the Delta, about 55 miles by rail north of Cairo. It has large public buildings, a palace of the Khedive, bazaars and three important annual fairs. The centre of education is the Mosque of El Ahmadi where in 1914 2,860 students and 113 professors were registered. Pop. about 59,000.

TANTALITE. A rare mineral consisting of tantalite of iron and manganese, with 72.4 per cent of tantalum when pure. An important source of that metal, at one time used extensively for filaments for incandescent electric lamps; obtained in Black Hills of South Dakota and in Virginia.

TANTALUM, chemical symbal Ta, atomic weight 183, is a rare element found by Ekeberg (1803) in a mineral afterward called tantalite ($FeTa_2O_6$) obtained from Finland. It is also found in the minerals samarskite, yttrotantalite and fergusonite. The other rare element columbium is usually found with it. The metal is obtained by heating the potassium and tantalum fluoride with metallic potassium and extracting the potassium fluoride with water. It is a black substance with a metallic lustre, insoluble in sulphuric, hydrochloric or nitric acids or aqua regia, but soluble in hydrofluoric acid. Like columbium it ignites when heated in the air, forming tantalum oxide, Ta_2O_5. This oxide unites with certain metallic oxides or hydroxides to form compounds called tantalates which may be considered as derived from hypothetical acids called tantalic acids. Tantalum is used in the manufacture of electric lamps. It is found in pegmatite veins in the Black Hills of South Dakota and at other places in the United States. The chief supply comes from Australia and Scandinavia.

TANTALUS, tăn'ta-lŭs, in Greek mythology, king of Phrygia or Lydia; son of Zeus or Tmolus. Tradition does not agree as to the crime by which he forfeited the favor of Zeus and merited condign punishment. According to one account he offended Zeus by his perfidy; according to another he stole away the nectar and ambrosia from heaven, and a third story is that he murdered his own son Pelops and served him up for some of the gods. Homer represents him as standing up to his throat in water, with the most delicious fruits hanging over his head, which, when he attempts to quench his thirst or to appease his hunger, elude his grasp. According to Pindar a great rock is suspended over his head, which constantly threatens to fall and crush him.

TANTIA TOPI, tän'tē-ä tō'pē («the weaver who became an artilleryman»): b. Bithur, near Cawnpore, India, about 1819; d. 18 April 1859. Rebel leader during the Indian Mutiny of 1857. He displayed marked ability; beginning as a lieutenant of Nana Sahib, after the flight of the latter into Nepal, he assumed command and continued the war for months, putting the English to no end of trouble, being the last rebel in the field. He was finally captured, tried and hanged in April 1859.

TANTRA, the name given in Hindu religious lore, to dialogues between the god Siva and his bride in one of her many forms, but chiefly as Uma and Parvati. The Tantrikas or followers of the Tantras, consider them a fifth Veda and attribute to them equal antiquity and superior authority. In them is found instruction in the methods of acquiring six superior faculties, as what would now be termed clairvoyance, second sight, observation on the astral plane, leaving of the physical body, etc. Meditation and its results is dealt with at great length, breathing instructions are given that suggest modern Yogi practice and there is instruction in the languages of animals. Consult 'The Tantra of the Great Liberator' (trans. London 1913). See INDIA.

TANTUM ERGO, tăn-tŭm ĕr'gō, the hymn sung in the Roman Catholic Church at benediction with the Holy Sacrament.

TANZIMAT. See TURKEY, *Government*.

TAO TE KING. Laotze, author of the 'Tao Te King,' «Book of the Way and Virtue,» lived in the 6th century B.C., and was keeper of the archives at the capital of the Chau, where Kongtse (Confucius) visited him. Later many legends, borrowed from Buddhism, gathered around his memory, until he became chief deity of the Taoists and his 'Tao Te King' their chief scripture. (See TAOISM). The 'Tao Te King' treats the world, man, morality and politics in reference to Tao, variously translated Way, Word, Reason, Nature, God. An understanding of the 'Tao Te King' is greatly aided by familiarity with Brahmanic and other mysticism, and Douglas even supposes that Laotze derived his doctrine from India; but if so he thoroughly assimilated it to the Chinese mind, while his references to Chinese antiquity indicate originality. In any case, Tao is distinguished from the ontological Brahma by the characteristic Chinese stress upon its ethical content. Tao is the Absolute which unfolds its mysterious nature into Shangti (the Chinese personal god), the rational world and moral man; and will finally withdraw all three again into itself. After introducing his Tao, Laotze passes from one theme to another without logical sequence, but always meaning to exemplify the working of Tao, limited. as usual with the Chinese, to the moral and political spheres. Laotze was no philosophic dreamer; but, like his great rival, Kongtse, was offering a remedy for the troublous times in which they lived. Laotze's remedy was a return to Arcadian simplicity, such as existed before rules and laws were devised or needed. With this pessimistic rejection of entire human culture, Laotze constantly joins rejection of its base features, such as ambition, pride, loquacity and greed; while he commends its obscure and weak but indispensable elements. In the course of this exposition, many a gem of insight is brought to light, though often embedded in dull earth.

Selections from the 'Tao Te King'.— «Therefore the sage, in the exercise of his government, empties the peoples' minds, fills their bellies, weakens their wills, strengthens their bones. He constantly tries to keep them without knowledge and without desire, and where there are those who have knowledge, to keep them from presuming to act on it. Where there is this abstinence from action, good order is universal.»

«There is no guilt greater than to sanction ambition, no calamity greater than to be discontented with one's lot, no fault greater than the wish to be getting. Therefore the sufficiency of contentment is an enduring and unchanging sufficiency.»

«To those who are good to me, I am good; and to those who are not good to me, I am also good, and thus all get to be good. To those who are sincere with me, I am sincere; and to those who are not sincere with me, I am also sincere, and thus all get to be sincere. The sage does not accumulate for himself. The more that he expends for others, the more does he possess of his own; the more that he gives to others, the more does he have himself.» Consult Legge, J., 'The Texts of Taoism' (2 vols., in 'Sacred Books of the East').

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TAOISM. Taoism ranks with Confucianism and Buddhism as the three great religions of China, which amount in practice to one religious compound, wherein Confucianism is politico-moral and ceremonial, Taoism is religious and magical, while Buddhism deals in metempsychosis and the future life. Only the priests are exclusive followers of either Taoism or Buddhism. There are even «temples of the three doctrines,» where idols of Buddha and Laotze stand on either side of Kongtze. The Chinese ask about a religion not, «Is it true?» but «Is it moral?» Tested thus, all their religions seem to the Chinese acceptable.

Taoism is the folk-faith of the Chinese, primitive but receiving various accretions through the centuries, such as a corrupted form of Laotze's doctrine of the Tao (from which Taoism takes its name) in the 6th century B.C., a magician deified as Yu Hwang in the 7th century A.D. and Kwanti a soldier deified as War-god only in 1828. Especially in the three centuries B.C., emperors and folk alike, under the leadership of Taoist priests, neglected labor to search for the elixir of life and for power to transmute base metals into gold. Thus Taoism came to include most of the national hero-worship and nature-worship (of a type lower than Confucianism) and most of the divination and magic, the latter including *fangshui*, the Chinese geomancy, according to which the location of a house or a grave depends on supposed magnetic currents, the azure dragon, the white tiger and the like. This folly is strong enough to form the chief obstacle to civil engineering in China, as when a telegraph pole would disturb the *fangshui* of a region or a railway that of a cemetery!

The gods of Taoism furnish a good index to its heterogeneous origin. The San Ching, «Three Pure Ones,» are simply a triplication of Laotze, done to correspond with a Buddhist triplet. But, since these are sunk in contemplation, the superintendence of mundane affairs falls to Yu Hwang Shang Ti, «Gemmeous Sovereign God.» The first elements have souls which rose to become the five planets and thus divine. Many stars are deified. The Dragon-king, a familiar feature of Chinese processions, seen even in America, represents water in its varied forms and, therefore, has numerous temples beside seas and rivers and is discerned among rain clouds. Sun cult survives in the bonfires of the spring festival. Licentious festivals were long ago suppressed in accord with the politico-ethical nature of the dominant Confucianism. Sacred animals are the fox, snake, hedgehog and weasel; sacred trees are the cassia, willow, banyan, pine and peach. To the ancestral tablets and an image or picture of the Kitchen-god (originally a Fire-god) found in every Chinese house the Taoist adds certain other figures according to locality, trade and preference.

Taoism worships also certain culture-gods who preside over various vocations. Thus, students revere Wan-chang (a deified scholar) as God of Letters, soldiers worship a deified soldier as Kwanti the God of War, and tradespeople worship Tsai-Shin, God of Riches. Besides such great gods there are innumerable *shin* «spirits,» of whom Chinese live in dread by day and especially night.

The priests of Taoism are probably cognate with the *shaman* of Siberia, but its monks, nuns, pope, monasteries and temples were copied from Buddhism. These priests conduct the ritual for the city and State gods, purify streets, houses and persons from evil spirits, and prepare paper amulets for pasting on doorways to exclude spirits. Though Taoist priests marry, their vocation is not hereditary, they are recruited from the lowest classes, are ignorant and immoral, and are generally despised by the *literati*, the learned officials of China. From these priest-magicians one must distinguish the monks who observe Laotze's principles by celibacy, seclusion and mystical communing.

The Taoist scripture is far less the recondite 'Tao Te King' (q.v.) of Laotze than «The Tractate of Actions and their Retributions,» an anonymous tract composed about the 11th century A.D., which is universally popular. Its 212 brief statements fall into five sections. The first of these declares that happiness follows virtue as misery follows vice; the second states that «spirits in heaven and earth,» in «the great Bear constellation» and within «men's person» execute this earthly theodicy by deducting some days from a man's life; the third specifies the virtues man must practice and their reward in making him an «immortal»; the fourth, and by far the longest, names the vices he must shun; while the fifth provides for repentance and enacts a new rule of theodicy. The tract is characteristically Chinese, agreeing with Confucianism in its stress upon morality and in its belief in an earthly theodicy; but its doctrine of the immortals probably originated from Buddhism. Another popular religious tract, the «Book of Secret Blessings,» expresses in 541 words brief moral rules with a flavor equally of Taoism, Confucianism and Buddhism, by all of which indeed it is approved. In subsequent centuries Taoism further adopted from Buddhism its doctrine of hells and it exhibits in its temples realistic figures of the damned under torture. Foreigners name such a temple «Chamber of Horrors,» and its gruesome spectacles are well adapted to terrorize the obtuse minds of the Chinese masses.

Consult Mayers, W. F., 'The Chinese Reader's Manual' (1874); Edkins, J., 'Religion in China' (1884); Douglas, R. K., 'Confucianism and Taoism' (1887); Legge, J., 'The Texts of Taoism,' 2 vols., in 'Sacred Books of the East.'

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TAPAJOS, tä-pä-zhos', Brazil, a tributary of the Amazon, formed by the confluence of the Arinos and Juruena, which rise on the edge of the Brazilian plateau in the state of Matto Grosso. The main stream is at first hemmed in by mountains and obstructed at intervals by rapids, but after it enters the state of Para it is a broad and deep stream. It enters the Amazon at Santarem in about long. 54° 30′ W. A few miles above its mouth it broadens into a lake-like expansion 12 miles wide and 75 miles long. The river is 1,040 miles long and steamers ply on it for 210 miles.

TAPESTRIES. The *peristromata* of the ancient Babylonians were highly praised by Lucretius, Plautus, Stichus, Martial and Italicus and have been considered as tapestry work of some kind. That they were a costly and greatly admired product is proven by such facts as that Metullus Scipio paid 800,000 sesterces (about $40,000) of their money for such work and Nero 4,000,000 (about $200,000). Homer writes of tapestries of great beauty woven by the Greeks; the Book of Exodus speaks of textile hangings done by the Hebrews. But all these may have been embroideries and not woven on a loom, for it is certain the «Sarrazinois carpets,» made earlier than the 12th century, were of embroidery work, not woven. The walls of many European Continental churches and princely palaces were covered with high warp (*haute lisse*) tapestry hangings by the 13th century. And the tenterhooks are found on the walls of halls in mansions of the 14th century from which the tapestries were suspended. Certain textile fabrics have been unearthed from the remains of the ancient Panopolis (Fayoum) which are true tapestries in our modern sense of the word. The history of their production is in doubt but they have been called «Coptic tapestries.» They date from different periods ranging from the 2d to the 8th or 9th centuries and have always been discovered in the form of narrow strips attached to clothing as a border decoration. These very ancient pieces display crude decorative designs in several colors.

Gothic Tapestries.— By the 13th century, incited by the Oriental works of art brought back by the returning Crusaders, Europe started an era of industrial art work. Flanders progressed most rapidly in the art of weaving tapestries and her «imaged cloths» (*draps imagés*) produced at Arras quickly became famous; so much so that the term «arras» soon became the familiar name for tapestry and still remains so in some languages. Brussels became the next centre of this industry to be followed by Valenciennes and Tournay. From the last half of the 15th century to the middle of the 16th century the richness and pure beauty of the «Gothic» weavings produced have caused the period to be termed the Golden Age of tapestry; it is frequently referred to as the «Gothic-Renaissance.» Arras and Paris were now vieing with each other as the principal centres of production. Every royal court and every baron and knight showed enthusiastic energy in acquiring these lovely coverings to hide the bareness of the stone walls and to act as curtains for the door openings of their castle interiors. The work of the tapestry ateliers was pushed strenuously to meet the great demand; and when Paris fell to the British arms whole Flemish provinces were given over to the industry to meet the still greater demand. But the persecutions of Charles the Bold drove the weavers (1477) from Flanders to bring a more flourishing industry to Brussels and Bruges to the loss of Arras and Liège. The tapestry products dating from 1483 to 1515 are generally considered by connoisseurs as the greatest achievements of the weavers' looms known from the point of pure art. But these beautiful hangings were not confined to the castles of royalty and nobility, for the wealthy merchants acquired them and displayed them from windows and balconies for the admiration of the passing crowd when the streets were decorated in honor of royal and civic processions and fêtes. The lists, at tournaments, were gay with such rich decorations. With the advance of time we find primitive stiffness in depiction, entailed with the Byzantine influence and ecclesiastical demands, gradually pass to the soft curves of naturalistic expression. The great space, formerly divided up into numerous scenes by quaint separating motifs of Gothic columns and arches, now becomes one of scenes blending into one another, later to be given over to one main scenic picture. The backgrounds that in the early Gothic weaves were occupied by dense masses of plant life (an Oriental decorative method, doubtless acquired through the Crusades) and known to us as «verdures,» pass to landscapes and castles lacking in perspective. These *verdures* are known to the auctioneer and his catalogue as «mille-fleurs» on account of the many little blossoms peeping out from the leafage. Another distinctive style was called «à personnages» crowded in the background with *persons* streaming from hills, churches, palaces. Belonging to this early period of unequaled art we find such talented tapissiers as Nicolas (or Colin) Bataille, the Parisian, of the 14th century, who worked in France and Flanders; Jacques Dourdin, who worked under the Duke of Burgundy. A clever tapestry designer was Jan van Room (Jean de Rome) in Gothic-Renaissance style. These figure-decorated pieces are known as «historiated.»

Renaissance.— The decadence of the tapestry art sets in with the 16th century; the textile now attempts to imitate the painted canvas, the weave in wool to simulate brush work in pigments. To get this strictly artificial effect the few simple woolen dyes have to be multiplied into innumerable hundreds of color tones and shades. The genius of a Raphael is called into play to design (1515) the «Acts of the Apostles» set of cartoons for tapestries to adorn the Sistine Chapel at Rome. In about four years Peter van Aelst, at Brussels, had reproduced the great work into color in the loom. They cost Pope Leo over $130,000, in money of that date. This ended the pure method of tapestry treatment in the Flemish ateliers and Renaissance painting in wool takes the place of Gothic, for the weavers of Brussels and other northern centres now got cartoons from Mantegna, Paolo Veronese, Andre del Sarto, Giulio Romano and other Italian artists to follow out on their looms. The «Acts of the Apostles» designs were later reproduced in most European centres. Wilhelm de Pannemaker was noted for his work in this period and style, as were the Pannemaker family. With the enormously increased demand the ateliers grew vastly in numbers and we have centres in Brussels, Arras, Tournai, Bruges, Enghien, Oudenarde, Middlebourg, Lille, Antwerp and Delft. As might be expected with a pressing demand much greater than the supply, haste and deterioration set in from careless execution. Low warp (*basse lisses*) were started. Rubens was making cartoons for the Netherlands now.

Italian Tapestry Factories.— Already in 1420 Johannes Thomae de Francia (French) was managing, at Mantua, an atelier for the Gonzaga family. Succeeding him came Nicolas, Guidone, Adamante (all French). Flemings were employed about 1450 (Rinaldo Boteram of Brussels, and one Rubichetto). Giovanni dei Conradi and Andre Mantegna did cartoons. In Venice looms were started by John of Bruges and Valentine of Arras in 1421. Boteram set up looms also in Siena. Renault de Maincourt (about 1455) did «The Creation of the World» for Pope Nicolas V. In 1441 Ferrara had looms worked by the Flemings Pietro di Andrea and Giacomo de Angelo; while Nicolas and John Karcher worked there with Lucas Cornelisz the designer. Rost and five other Flemings arrived, a school was opened and a local artist, Battista Dosso, designed «Life of Hercules,» «Scenes from Metamorphoses» and other beautiful work. Extant pieces of this school are (in Ferrara Cathedral) «Story of Saint George and Saint Maurelius» and (in Como Cathedral) «Story of the Virgin.» In Florence the Medici established an atelier called «Arrezaria Medicea» (1546–1737), under Karcher and Rost. Johan van der Straaten was director about 1570 and did prolific work. Many pieces are in the Florence Tapestry Museum, including the Karcher and Rost best productions «The Story of Joseph» in 20 pieces. Cartoons were designed by Jacopo Sansovino, Bacchiacca and others. Master weavers (17th century) were Papini, van Asselt, Lefèvre, Pollastri, the two Termini, Bartoli, Manzi, Cavalieri, Bucci. In Rome, Cardinal Barberini (1633) established an atelier with Jean François Romanelli as art director, Giacomo della Riviera director of works, M. Wauters (of Flanders) was a creator. «Scenes from the Life of Christ,» in 11 pieces, in the Cathedral of Saint John the Divine, New York, are from this factory. In the Hospitale Saint Michele, Rome, Pope Clement XI started (1710) an atelier with Jean Simonet of Paris manager, and A. Procaccini art director. Ferloni was manager from 1717 to 1770. In Naples (1737), the Florence Medici factory having closed, its weavers started here and ran till 1799. Under Benedetto da Milano the Vigevano works started (16th century) and produced the «Triulse Months» for Marshal Triulse, now in this family's Milan palace.

German Factories.— Otto-Heinrich had an atelier at Launingen in the 16th century. Peter Candid designed and Hans van de Biest wove (17th century) «The Four Seasons» and «Day» and «Night,» six pieces, in the Munich Museum.

French Factories.—François Premier, after his Italian campaign, started an atelier (about 1535) at Fontainebleau. The «History of Diana» was done in honor of Diana of Poitiers. Under his son (Henri II) it became defunct; but (1551) Henri opened an atelier at the orphan asylum, La Trinité, employing the children on the work. The «History of Mausolus and Artemisia» (15 pieces) were made here by Maurice du Bourg, its chief, from the designs of Larembert and Caron. Other factories have reproduced it. Henri IV started both high and low warp looms in 1597 in faubourg Saint Antoine ateliers, under du Bourg and Daurent; and, about 1601, Flemish artisans were invited to Paris. Frans van den Planken came from Oudenarde and Marc de Coomans from Brussels and started an atelier in Paris with branches in Tours and Amiens. Henri IV decided to accelerate the industry still more by installing du Bourg and Laurent in the Louvre and de la Planche (van den Planken) with Coomans in Les Tournelles palace. The latter works was moved to faubourg Saint Marceau, Paris. Louis XIV patronized the industry and Pierre Lefèvre and his son Jean (Florence weavers) came to Paris in 1647. The high warp looms of Tours got Cardinal Richelieu's patronage. Rheims, under direction of Daniel Pepersack, produced «The Story of Christ» and other works. Fouquet of Vaux let Maincy start an atelier (1658) on his estate and Le Brun drew cartoons for it («The Hunt of Meleager»); Louis Blammaert directed the Flemish weavers. When Fouquet, as successor of Mazarin, fell in disgrace, the Maincy factory was closed, after only three years' operation.

Beauvais Tapestry.— Minister Colbert (1664) persuaded Louis Hinert, owner of Flanders ateliers, to move his looms to Beauvais under such attractions as a subsidy, assurance of Court orders and 30 years' privilege. Hinert was bankrupt by 1684 and was succeeded by Philipe Behagle, who started making full-sized figure pieces. High and low warp looms were operated, but the large pieces showed very little demand. Behagle started a school of design under management of Le Pape and many of the small pieces (low warp), of great beauty, for furniture, came from designs of this class. On Behagle's death his sons failed and the brothers Filleul took over the business only to fail likewise. In 1722 the atelier was run by Sieur de Mérou, who engaged Jean-Baptiste Oudry (from the Gobelins). Oudry's genius in designing cartoons and management made Beauvais noted. Perfect workmanship marks this period; verdures are delightful, cute ducks, pheasants, foxes, dogs charm connoisseurs. Charles Natoire (of Gobelins) used his talent on furniture. Mérou's financial losses brought Nicholas Besnier as successor. Noted designers of Beauvais pieces are François Boucher, Leprince, Casanova, etc. Low warp pieces predominate. Besnier's death in 1753, followed by the death of Oudry two years later, injured art values of future Beauvais pieces although, under the auspices of André-Charlemagne Charron (1753–1780) the factory was quite a success. From 1780 Sieur de Mérou (from Aubusson) was director, and introduced the fabrication of pile rugs (Savonnerie style). The Revolution injured the industry and for one year it was closed but the factory has been kept running ever since. Among extant Beauvais pieces are «Conquests of Louis the Great» (two pieces only) in Florence; Raphael's «Acts of the Apostles» (eight pieces), one set in Beauvais Cathedral, another in the French National Collection; «Adventures of Telemachus» (six pieces) in Royal Spanish Collection, several in Paris; «Battles of Charles XII of Sweden» (four pieces) in Royal Swedish Collection. Oudry's «Fables of La Fontaine» designs for chairs gained great popularity and were reproduced prolifically. In the archbishop's palace at Aix-en-Provence are a set of Natoire's «Don Quixote» (10 pieces). Quite a large number of Boucher's pieces are in the United States.

Aubusson Tapestry.— The origin of this factory is in doubt, but the Duchess of Valentinois' will (dated 1507) mentions the «tappicerie de Felletin,» and Felletin is a town near Aubusson. Henry IV (late 16th century) lent the Felletin and Aubusson ateliers assistance by forbidding Flemish tapestry imports. Savary's 'Dictionnaire du Commerce' (1641) says: «There are also two other French tapestry factories, one at Aubusson in Auvergne, and the other at Felletin in La Marché.» In 1637 Aubusson had about 2,000 operatives, but both material and designs were of a low order as well as the dyes, and weavers were leaving. Colbert promised a talented artist and an expert dyer. But they never came. The king permitted the use of the title «Royal Manufacture» and promised a good painter, who did not appear. Financial conditions at the Court were bad. However, the factory continued. But in 1685 the revocation of the Edict of Nantes set the best weavers in flight, for they were Protestants, much to the injury of the factory. Louis XV in 1731 sent the efficient dyer (Sieur Fizameau from the Gobelins) and the promised painter (Jean-Joseph Dumons). Dumons' designs were a success. Fizameau was soon succeeded by Pierre de Montezert. An ordinance of 1732 enforced the weaving of the initials of the town and weaver into the blue border. The Revolution closed the factory, but ever since it has been running with success. Aubusson looms are all low warp. The product is furniture tapestry.

Savonnerie Tapestry.— The textile produced at this factory is not what is known generally under the name of *tapestry* because it has a velvet-like pile. It is a decorative material which originated in the East and had been called *longue laine* (long wool) or *à la façon Perse*, also *after the fashion of Turkey*. Pierre Dupont and Simon Lourdet started looms for this work in 1627 in the Louvre with royal license «to weave carpets in the style of the Orient, with gold and silver.» The plant was moved in 1631 to the old soap works (*savonnerie*) at Chaillot. Louis XIV permitted (1712) the works to assume the title «Manufacture royale des Meubles de la Couronne et des Tapis façon de Perse et du Levant.» They gained the same privileges as the Gobelins. The king and his successors, Louis XV and XVI, patronized the industry and gave extensive orders. While the process was that of knotted work cut to pile, it has ever been classed as tapestry. Much of the product has been used on furniture as upholstery though properly being a carpet textile. Designs run to branched foliage and architectural motifs with a medallion or other centre.

Other French factories were as follows: Fontainebleau; a tapestry atelier was started here (about 1535) by François Premier with Philibert Babou as manager and Sebastian Serlio (Italian architect) as art director. Le Primatice drew the cartoons. It was discontinued as unprofitable while under the direction of Philibert Delorme during the reign of Henry II. A factory was opened by Raphael de la Planche (son of Frans van den Planken) at rue de la Chaise, faubourg Saint Germain, Paris, on the death of his father. An atelier at Vaux (17th century) had the honor of having to work on the «Story of Constantine» and «Hunts of Meleager» designed for it by Lebrun, director of the Gobelins.

English Tapestries.— An existing piece of tapestry containing the coat-of-arms of the first Earl of Pembroke proves that the industry was established here already in the 16th century. It was woven by Richard Hyckes of Barcheston, who had another atelier at Weston. There are two tapestry maps from this weaver's hands in the Oxford Bodleian Library. The Sheldon family continued the work into the next century. William Benood (1670) had an atelier at Lambeth, London, of whose work Haddon Hall holds the «Vulcan and Venus» set (four pieces). Glenham Hall owns four «Indo-Chinese» pieces from the loom of John Vanderbank (end of 17th century), «manager of the King's Wardrobe,» who also produced «The Elements» (three pieces) at Burley House; his atelier was in Great Queen street, Soho, London. Early in the 18th century Stephen Demay wove the «Hero and Leander» panels and «Acts of the Apostles,» still extant, and Peter Parisot, in the same period, had an atelier at Fulham, London. The name Bradshaw is woven in a sofa covering of this century at Belton House.

Mortlake.— King James I smuggled into England 50 expert Flemish weavers and established, in 1619, a tapestry factory at Mortlake. Sir Francis Crane was the instigator of the movement. Orphans from the «Foundlings

TAPESTRIES

1 Gothic Tapestry (15th Century)
2 "Flora"—Flemish Tapestry (17th Century)
3 "Summer." American Tapestry from the Baumgarten Ateliers
4 Flemish Verdure (17th Century)

(By courtesy of Wm. Baumgarten & Co.)

Hospital» were apprenticed under the superintendence of Philip de Maecht, a Fleming. His productions were marked P. D. M. often. Designs were done by Francis Clein (or Cleyn) from Denmark. The king's promised financial assistance was not forthcoming and Sir Francis, having sunk all his capital, made an appeal to his sovereign for cash to pay overdue wages of his weavers. The Prince of Wales gave financial assistance and obtained some funds from the king. On the king's death (1625) his successor, Charles I, aided further (as when Prince) and Crane was repaid his cash losses and given lands, while the factory became a financial success. England produced the finest wool ever used on tapestry work (it was always in great demand in Flanders and France), and now with Italian art designs and Flemish operators Mortlake, for 10 years, brought forth the grandest tapestry pieces the world ever saw. Capt. Richard Crane, on the founder's death (1636) carried on the work unsuccessfully; civil war and the beheading of the king injured the quality and quantity of the work. Sir Gilbert Pickering, under the Commonwealth, became head of the factory. A Hampton Court copy of Mantegna's «Triumph of Cæsar» was duplicated. Cheaper and poorer tapestries from France and the Netherlands were more popular with a war-impoverished people, however, and the factory closed in 1703. Mortlake reproduced Raphael's great «Acts of the Apostles» with border designs by Van Dyck; Rubens' «Story of Achilles» in six pieces; Cleyn's «Story of Vulcan» and «History of Hero and Leander.» «Vulcan's Complaint to Jupiter» is in an American collection (loaned to the Metropolitan Museum of Art, New York); the Swedish Royal collection owns «Hero and Leander» (five pieces); «Vulcan and Venus» pieces are in the French National Collection and in America; «Naval Battle of Soleby» (three pieces) is in Hampton Court; three sets of Mortlake «Acts of the Apostles» are in the French collection.

Merton.— In 1881 William Morris founded the Merton Works, «The Goose Girl,» from a Walter Crane cartoon, being the first production. Designs by Burne-Jones were next carried out. Among the best known Merton pieces are «Story of the Holy Grail» (in Stanmore Hall); «The Seasons» (Victoria and Albert Museum); «Star of Bethlehem» (in Oxford); «Primavera,» «Flora,» «Pomona,» etc. Merton tapestries are of coarse weave, 10 to 16 ribs per inch.

Spanish Looms.—The Santa Barbara (Madrid) atelier opened, in 1720, under patronage of Philip V, with the Jacques Vandergoten family, from Antwerp, as experts. Some of the noted 18th century 92 pieces, woven from 45 designs of Francisco de Goya, are in Escurial Palace, others in the Prado. The factory is still in operation.

Russian Looms.— In 1716 the Imperial Tapestry Works was founded by Peter the Great, with Behacle and Beauvais operators as experts.

Japanese Tapestries are of very delicate and beautiful design, but very rare, hence few are discoverable in connoisseurs' collections.

American Looms.— William Baumgarten, in 1893, started some tapestry looms at 321 Fifth avenue, New York City, with M. Fousadier as manager. After several pieces had been finished (one in the Field Columbian Museum, Chicago), the industry was moved to Williamsbridge, a suburb, and more weavers, from Aubusson, were engaged. A $20,000 set of wall panels and furniture coverings (after Boucher) was produced for P. A. B. Widener of Philadelphia. It took 13 months to execute. Next were some wall panels in the directors' room of the New York Life Insurance Company. Beautiful work has been done for such patrons as Mrs. Sheperd of Scarborough, Jacob H. Schiff, Charles M. Schwab, J. B. Ford, D. G. Reid, etc. Here also are produced floor pieces in Aubusson pile style.

Extant Masterpieces.— Of *Gothic verdures* we have in America (Metropolitan Museum, New York and elsewhere) «Baillée des Roses,» «Capture of Jerusalem by Titus»; Cluny Museum has «Lady of the Unicorn»; Victoria and Albert Museum (London) has four «Hunting Scenes»; before the World War Rheims Cathedral had «Coronation of Clovis,» «Capture of Soissons,» «Story of the Wonderful Stag,» «Victory over Gondebout,» etc. Of *Gothic* tapestries dating from the 12th to 15th centuries there are in the Cathedral at Angiers a set of seven «Apocalypse»; in the Brussels Museum were «Four Philosophers,» «Abraham and Isaac,» «Presentation of Infant Jesus in the Temple»; in Halberstadt Cathedral, «Christ and Apostles»; pieces (fragments) from the Saint Gereon Church, Cologne, are in museums at London, Lyons, Nuremberg. Arras productions of this period, known and identified, had become reduced to a single set before the war; the «Story of Saint Piat and Saint Eleutherius» in Tournay Cathedral. *Late Gothic* examples are in the Louvre, «Last Judgment,» «Combat of the Vices and the Virtues,» «Creation,» «Triumph of Christ,» «Christ Inspiring Faith,» «Scenes» from New Testament, «Creation»; two David tapestries in Brussels Museum; «Story of David» in Cluny Museum. *Transition Gothic-Renaissance* pieces extant: in Rheims were «Story of Saint Remi,» «Story of the Virgin»; «Story of Saint Stephen» (nine pieces) is in Cluny Museum; «Life of Christ» in Aix-en-Provence Cathedral; «Life of Christ» in La Chaise-Dieu (both latter 14 pieces). All are without borders. *Renaissance* pieces are «Acts of the Apostles» in 10 pieces in Beauvais Cathedral, French National Collection, Hampton Court, Dresden Museum, Berlin Museum, Imperial Austrian Collection, Royal Spanish Collection, and in Loretto Cathedral. Many other splendid examples are in private American collections. Fragments of the 15th century Burgundian «Sacraments» (J. P. Morgan donation) are in the Metropolitan Museum, New York.

Tapestry Characteristics.— In identifying the location of the weave special attention is given to the *border,* because special borders were designed for replicas of the noted pieces. The tape border or binding, known as the «galloon» often contains the marks of the weavers, but they are often absent. The primitive design is a characteristic of Gothic tapestry, such as the Byzantine «stiffness» of expression and folds in clothing, the *flatness* or absence of what artists term «atmosphere,» the lack of perspective. Early works (14th and 15th centuries) usually have but a single subject, few personages. Pointed Gothic architecture in the piece places its period, as do the capitals and shafts of columns. Of course, Renaissance tapestries display florid columns. The earliest pieces have no border — these *verdures* have simple flowers filling spaces. To find dates the costume is of great assistance; when armor appears the style affords a good clue. Much may be proven by the makeup of the lettering. Renaissance pieces are devoted to classic subjects, battle scenes, kings, queens and their courts. Borders are a clue; earliest were of woven tape (*galloon*) in a single tone. Then came frames of fruit, flowers, foliage (also ribbons sometimes), they are Gothic. Next we arrive at scenes depicted in square divisions, they are Renaissance. The relative value of the border keeps growing as well as the size, and, by the 18th century, we have the central subject actually crowded for space to make room for the elaborated border subjects. In Louis XV tapestries we arrive at actual gold picture frames in textile, moldings and all.

Tapestry Marks.— The first producers' marks appeared in 1528, when Brussels passed the ordinance by which each piece had to have the town mark, "a heraldic shield between two B's" in either capitals or minuscules. The two B's either face the same way or, sometimes, the left B is depicted backwards. It appears on the galloon and generally in a lighter tone than the body. There was also the merchant's mark. This law only affected those pieces of about 13 feet or over, not the small ones (which were few in early days). In the pieces from the Spanish ateliers of Wilhelm de Pannemaker his W P is found in several confusing combinations, and the number 4 frequently is found combined with the W. The initials J G are said to be the weave mark of Jacques Geubel. The Bruges ateliers used two B's traversed by a crown. A gyronne of four in a shield or circle was the mark of Pierre of Enghien. In the 17th century we find initials frequently, as two C's intertwined for Charles Coomans; A. C. monogram for Alexander Coomans; J. F. for Jean Lefèvre; P with a fleur-de-lis stood for Paris. A fowl roasting on a spit was the Jean Rost sign; Florence used a lily; Mortlake a shield with a cross entire; Tournay a castellated tower; Lille a peculiar shield charged with a lily and side initials L and F; Amiens used a double S entwined; Beauvais a red heart, white pale and two B's; Munich a shield charged with a child standing with arms outstretched on white background (*field*).

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CLEMENT W. COUMBE.

TAPESTRIES, Manufacture of. The direct history of tapestries has been studied and written by many European and by a very few American savants. The rise and fall of numerous ateliers and of tapestry-weaving centres have been traced, quantities of marks and monograms deciphered, long lists of master-weavers discovered and the technical processes of weaving at the different eras defined, but the collateral history of these art products remains to a great extent unwritten. In evidence of the interesting results researches in this direction may unfold, the arguments of a learned Frenchman in an essay which appeared some years ago almost tempt one to believe that the tapestries woven by Helen and Andromache, to represent the principal episodes in the siege of Troy, actually inspired the 'Iliad' and the 'Odyssey.' We have become fairly well acquainted with the social position tapestries occupied in different nations since the dawn of civilization, by studying the impressions they made upon the popular taste from age to age and by reading the history of the rôles they filled on hundreds of occasions of pomp and ceremony during many succeeding centuries. We have also become fairly well acquainted with the changes made in their style and character from the infancy to the maturity of the art, and with the alterations in the ideas they expressed throughout the same period, by patient research among documents from the great centres of production, by gleanings from the inventories of princes and other potentates and from newly discovered material concerning individual ateliers the existence of which had been long forgotten, but above all by careful study of the existing specimens wherever they can be found. Guiffrey, Muentz, Pinchart and Wauters have long since proven that tapestries often exhibit the finest and loftiest conceptions of many of the great masters, that at all epochs the most eminent artists designed models for them, and that they frequently constitute the only surviving examples of whole schools of paintings which without them would have been lost to the world. In addition they are as trustworthy interpretations of the characteristics and mannerisms of both schools and individuals as are paintings, and are more faithful exponents of the national ideas and sentiments of the country and era in which they were created, and, therefore, it is no longer possible to separate the history of paintings from that of storied tapestries.

Weaving.— Tapestries, or calling them by their classical name — «Arras» — are decorative pictures or designs in tissue which are made by interweaving variously colored woof threads with undyed warp threads after the latter have been extended either vertically or horizontally upon a loom. This interweaving is done with an implement called a «broche» in French, which is neither a shuttle nor a bobbin, but partakes of the character of both and for which there is no equivalent word in English. The picture represented is developed upon the warp by the different colors of the woof threads. Needles are never used in weaving tapestries. In the process of weaving the woof becomes practically an integral portion of the completed structure. Art tapestries can only be woven by trained artists who, in the best periods of the art, always interpreted and never copied a model. Their work cannot be altered nor improved to any important extent as they go along except by destroying and re-weaving a defective part. There is no similarity whatever in hand-woven tapestries and machine-woven fabrics which masquerade under the same name, since tapestries are woven in an entirely different manner from fabrics; since they have no nap; since each piece possesses a distinct originality and is not a mechanical repetition of the same subject; and since every thread of the warp is so completely encased by those of the woof that the warp is invisible on either side. There are two kinds of tapestries, «haute-lisse» and «basse-lisse.» Translated liberally, the former means «upright warp» and the latter «horizontal warp,» since the first kind are woven on upright and the second kind on horizontal looms. At Gobelins they weave only in haute-lisse, and at Beauvais, Aubusson and Malines, only in basse-lisse. In both kinds the warp threads are stretched on rollers so that they may be kept taut and parallel like the strings of a harp, but naturally very much closed together, as there are usually 22 to 26 of them to the inch. In the process of weaving both kinds about an ell in width of the warp forms a breadth of relay, and the weaver uses as many different broches as there are different tones and shades of color. In haute-lisse one end of a string is attached to every other warp thread in each relay, at a slight distance above the weaver's hands, and the other end is fastened to a crossbar above his head so that all these strings hang in loops within easy reach. By the assistance of these strings called «lisses» he manipulates the warp threads backward and forward with his left hand and passes the broche from right to left between as many or as few of them as he desires with his right hand. In basse-lisse these strings are attached by a mechanical contrivance to pedals at the base of the loom so that the weaver raises and depresses the warp threads with his feet, and having both hands free to pass the broche, he weaves about one-third faster than the weaver in haute-lisse.

Rapidity and Cost of Weaving.— The number of warp threads which are covered by one pass of the broche and one thread of the woof are only as many as are included in a single shade or tone of color. In background scenes and skies the woof-thread may cover at each pass from 30 to 60 warp threads, but when personages or their costumes are represented it rarely covers more than two or three of them. In short, it is the manifold changes in the coloring, the lights and shadows, the half-tones, and so on, which determine how many threads of the warp shall be covered by a thread of the woof at each pass of the broche.

Hatching the Colors.— In high art haute-lisses tapestries, well filled with personages, the artist-weaver can weave only about a yard square in a year. At the Gobelins, to-day, this yard square costs about $880, which does not include taxes, insurance, interest on cost of plant, rental for the apartments of the weavers, etc. The weaver passes from light to dark colors and from one shade or tone to another by weaving in threads of intermediate shades or tones in formations like the teeth of a comb and thus avoids the mosaic effect which would follow weaving two different colors side by side. This process is termed hatching the colors, and is one of the most difficult feats in tapestry weaving. In valuable antique tapestries the colors are usually hatched with such skill that the untrained eye does not readily discover where the different shades of the same color begin or end.

Difficulties of Weaving.— In both haute and basse-lisse the weaver works on the wrong side and the finished part faces away from instead of toward him. Consequently he is unable to criticize the progress of his work unless he walks around to the front of his loom in haute-lisse, and unless he raises it from its horizontal position in basse-lisse. In haute-lisse the cartoon is placed behind the weaver, and in basse-lisse it is placed beneath the warp. The weaver in haute-lisse translates the cartoon by sight, with nothing to direct his eye but the outlines of it that he has traced upon the warp, but he can, by walking round to the front of the tapestry, or by the aid of a mirror while seated take constant note of his work, and even make slight modifications in it. The weaver in basse-lisse, seeing but imperfectly what he translates, as the warp threads hide the cartoon to a certain extent, cannot examine his work, except at considerable trouble, until the tapestry is finished, when it is too late to remedy any defects. Naturally, therefore, the artist in haute-lisse has greater opportunities for noticing the effect of light and shadow and can more readily interpret or idealize the cartoons according to his own conceptions than can his brother in basse-lisse. For these reasons haute-lisse tapestries possess as a rule greater artistic value than basse-lisse. It may be said in a few words that haute-lisse are mostly creations from, and basse-lisse are mostly reproductions of, their respective cartoons.

The precautions taken by the weaver to verify the correctness and excellence of his work are, however, of little advantage if he does not possess the specially developed talents as well as the necessary skill and experience to insure success in his interpretations. He uses dry and supple materials which cannot be manipulated as readily as the semi-liquid colors of the painter, nor can the thickness of these materials be increased or diminished at will as can paints upon canvas. He cannot correct nor alter, nor even materially modify what he has done, nor erase and reproduce it with facility, as can the painter. He cannot varnish his production, nor employ any other of the multiplied accessories of the brush and the palette. His work grows almost imperceptibly and he is, therefore, unable to sieze the general effect of the entire composition in any other way than mentally. He cannot obtain transparency and harmony except by the complicated process of hatching the colors, and must be exact in choosing them and measurably correct in his drawing, although working on the wrong side. He can improve slight faults by packing the woof threads more or less closely together with a special kind of comb, but he cannot change faults in color or in drawing except by unweaving the defective part and renewing it totally. Is it any wonder that it requires at least 12 to 15 years to educate a novice in all the mysteries of the profession and that it took several generations of master-weavers to perfect the art of weaving storied tapestries? The tyro will not be able to tell a haute-lisse from a basse-lisse tapestry, and the amateur even is often at fault unless there should be a manifest defect visible, like a mark, monogram or inscription running backward. Since the cartoon in basse-lisse is placed beneath the warp, it faces the finished tapestry, and its subject is, therefore, reversed in the process of weaving, just as your signature or any other bit of writing is reversed on the blotting pad with which you dry it. No marks, monograms or inscriptions were usually painted upon the cartoon, consequently the weaver often made the mistake of weaving some of them in as he would write them, which naturally made them run backward in the finished tapestry. In basse and haute-lisse interpretations of the same cartoon, the subject faces the spectator in the former in an opposite direction from which it faces him in the latter. To avoid this difference it has been usual for a long time to furnish the basse-lisse weaver with a reversed model of the cartoon so that the scheme of the tapestry when finished should run as it would if woven in haute-lisse. Any one can, however, occasionally detect a basse-lisse tapestry on closely scrutinizing it with a microscope on the wrong side, by finding here and there the hairs from a man's beard. This may seem ludicrous, but the ancient basse-lisse weaver, according to existing illustrations, usually wore a full beard, and when he bent over his work to catch glimpses of the carton beneath the warp, he occasionally caught a hair or two of it between the threads of the warp and the woof. There are a number of embroideries miscalled tapestries, notably the historical Bayeux frieze which many authorities assert was made by Queen Matilda of Normandy, and her maids of honor, although there are many excellent reasons for doubting such assertions. It is needlework, and in no sense a tapestry.

History of Weaving.— The art of weaving tapestries was understood in the remotest ages, and was discovered but little later than the art of painting on walls or wooden panels, for the spirit of decoration manifested itself almost everywhere long before the dawn of civilization. It is a long way from the coarse and crude example used in ancient times by many wandering tribes in the decoration of their tents, to the sumptuous and refined textile paintings universally employed by the rich and noble in the 15th, 16th and 17th centuries to enhance the splendor of their palaces; nevertheless the student will find ample opportunity for serious thought and gratification in everything that elucidates the progressive steps in the prolonged march. In short he will find that the study of tapestries will lead him into fields which were practically closed for 100 years, and that it will open his eyes to new visions of beauty of the existence of which he had scarcely a suspicion. Until recently an ornamental decoration on a Grecian vase representing Penelope at her loom was presumed to be the most ancient visible evidence of the manner of weaving tapestries, but the discovery upon the walls of the hypogeum of Beni-Hassan el-Gadin of a painting finished about 3,000 years before the birth of Christ, upsets all previous calculations, since it represents two persons weaving at a loom very similar in many respects to those now in use at the Gobelins. There is a tradition among the Hebrews that the art was invented by the daughter of Noah; but some of the ancient philosophers and many of the ancient poets claim that the honor belongs to Pamphile, daughter of Apollo. Although Pliny describes in graphic language the sumptuous beauty of the industrial and decorative products of his era, yet he is unfortunately silent upon the manner in which they were woven, and the probable inventors of weaving them. Ovid, on the contrary, is delightfully explicit and not only gives the mythological origin of the art, in his description of the fabulous contest in tapestry weaving between the Lydian maiden and the goddess Minerva, but judging by his technical explanation of the process, one could well believe that he describes the manner in which tapestries are woven at the Gobelins to-day. According to the story Arachne was exceedingly vain of her dexterity in weaving and challenged Minerva to a trial of skill. The outraged goddess accepted, but vowed vengeance on the presumptuous damsel. Each attached the warp to the beam, and passed the slender broches in and out among the threads. Minerva wrought the scenes of her contests with Neptune, and Arachne the love exploits of Jupiter. The goddess could not forbear admiring the handiwork of the maiden, although enraged that a mortal should have dared to compete with an immortal. In her anger she destroyed the tapestry of Arachne, struck the damsel on the forehead with her broche, metamorphosed her into a spider, and bade her weave on forever.

Oldest Tapestries.— The oldest existing mural tapestries are no doubt the fragments from the Church of Saint Gereon in Cologne, which were woven in Europe in the 11th or 12th century. The oldest of all existing tapestries are no doubt those discovered in the Crimea by Stephani, the archæologian, who believes they were woven in Asia 400 years before the Christian era. The oldest I have ever seen are of Coptic origin and were found in the tombs of ancient Panopolis. They were woven in haute-lisse and are presumed to date from the 2d to the 9th centuries. Coptic tapestries were all used, in so far as known, in decorating costumes, as there is no evidence that any were woven to ornament houses. In consequence many have been preserved until this day because they were buried with the bodies of those who had worn them. They are mostly shaped like bands and were sewn around the bottoms of garments or made into chasubles, or worn around the neck and wrists like the lace collars and cuffs of the Hollanders in the Rembrandt and Hale portraits.

As Mural Decorations.—Throughout the history of art from the earliest records, tapestries have ranked as the most magnificent of mural decorations, and the most important factor in crowning with pomp and splendor grand tournaments, funerals of exalted personages, receptions to famous generals or renowned prelates, triumphal entries of sovereigns or distinguished conquerors, royal and princely marriages, and coronations of popes, emperors and kings. Everywhere they occupied the places of honor and were relied upon to create the profoundest effect and arouse the highest enthusiasm. Great generals carried them to the wars, and princes and monarchs did not hesitate to borrow from each other whenever they desired to give an entertainment of unusual magnificence. In patrician homes their rich warm colors brought out in exquisite relief the classical purity of the architecture and the beauty of the statuary, bronzes and gilded furniture. In churches, as Muentz poetically declares, they sifted the sunlight and thereby added to the mysterious shadows of these sanctuaries. When we read of the glorious rôle they played on hundreds of grand occasions, none of which can be referred to in the limited space of this article, we are at first fascinated and then amazed, for the facts so far outrun our liveliest imagination that they prove as thrilling as any romance of chivalric days, and as absorbing as any epic of ancient or modern times.

Nationalization of Weaving.— In no countries of Europe except France and Flanders did the art of weaving tapestries ever become thoroughly nationalized. There were many important ateliers established elsewhere, but nearly all had a comparatively ephemeral existence and rarely survived their founders. All connoisseurs regret the short life of the Mortlake atelier of England, for its «History of Vulcan» ranks among the most important series in existence. The Medicean ateliers of Florence lasted about a century and some of the superb specimens in the Florentine galleries issued from them. Of those founded under the ægis of the popes, that by Cardinal François Barberini was maintained by the family for nearly 50 years and created several magnificent series.

Tapestry Museums.— There are only two museums in Europe devoted exclusively to the exhibition of tapestries and textile products, to wit: the Gobelins in Paris, and the Crocetta in Florence. In all other cities, although some of them possess remarkable collections, their tapestries are displayed either in the royal or imperial palaces, or in the museums among the other objects of art. Those exposed at the Gobelins have been selected with especial care so that each piece shall be an object lesson to the student, enable him to distinguish the modifications in the methods of weaving at different epochs, criticize the results, and become acquainted with the changes from the first foundation of the Gobelins in 1603 to the present day. The most valuable and important state collections of storied tapestries are those in Paris, Madrid, Florence and Vienna. In each collection, except the last named, there are about 600 pieces. That in Paris is largely composed of tapestries woven in France and is unrivaled in its magnificent specimens of Gobelins and Beauvais manufacture. That in Madrid is largely composed of those woven in Flanders, and is remarkable for its wealth of superb Flemish specimens. That in Vienna is not as large nor as valuable as those in Florence, Paris or Madrid, but includes tapestries woven in all the great centres of production, although, as in Madrid, those woven in Flanders are in the majority. That in Florence is composed in nearer equal proportions of the products of France and Flanders than any of the rest, although the Italians claim that almost one-third of it was woven in Italy.

Flemish Art.— The work of the Flemish ateliers, studied in its entirety, constitutes an immense epic in warp and woof, illustrating religious and profane history, mythological episodes, legends of the saints, creations of the poets and novelists and celebrated acts of great men of all ages. Her master-weavers, however, did not confine themselves to these inexhaustible sources, but made admirable representations of nature's models, for, the truthfulness of their landscapes, the repose, softness and veracity of their background scenes, and the purity and reality of their garlands of flowers and fruits have received the unbounded admiration of connoisseurs for generations. Some of the historians of tapestries have failed to award Flanders her just rank as the greatest of all centres of tapestry weaving. For over three centuries she eclipsed all others in the magnificence and excellence of her products and in future ages when the tapestries of the latter part of the 18th and all of the 19th century have passed into oblivion, amateurs and connoisseurs will still recall the glory of her ateliers and still go into raptures over the tapestries which issued from them during the 15th, 16th and 17th centuries. During these 300 years she led the world in the production of practically perfect examples of textile painting, that is, tapestries which are rich in color, strong in decorative effect, graceful in drawing and with subjects adapted to the exigencies of the loom and the æsthetic requirements of wall decorations. Her tapestries of the first half of this period rarely contain more than 30 to 50 different tones and shades of color, the half tints and graduations having been made by hatching one color into another. In the 16th century Flemish tapestries reached their apogee. Her master-weavers, from their profound love of their art, wove as if inspired and painted both grandly and broadly in tissue. By careful and intelligent study they absorbed and interpreted even the motives to which the artists yielded when they designed the models and «often further idealized the latter's ideals.» Naturally, therefore, the productions of Flanders outrivaled those of any other part of Europe, but about the middle of the 17th century she was obliged to bow her proud head to her rival — Paris. As the taste and demand for tapestries grew, most of the sovereigns of Europe determined to establish ateliers for weaving them in their respective territories, but nearly all were obliged to depend upon Flanders for master-weavers capable of carrying their resolutions into effect. France was the only exception of any note, for the art of weaving tapestries had been introduced in that country at probably the same period as in Flanders. Although the French ateliers had languished all through the long years of her wars with England, yet the best of them had not succumbed. Under the fostering succor of Francis I and Henry II they showed renewed signs of life; under the wise policy of Henry IV and Louis XIII they gathered additional strength, and under the magnificent support of Louis XIV they outrivaled all competitors. Nevertheless Henry IV summoned celebrated Flemish master-weavers to France, loaded them with honors and showered inestimable privileges upon them, which Louis XIII and Louis XIV gladly continued and extended. The object of the French kings was to increase the demand for tapestries by introducing the cheaper methods of weaving then known in Flanders, as the lessened cost would bring them within the reach of the middle classes, whereas they had heretofore found purchasers only among the rich and the great. Finally, as these kings expected, French ideas and taste prevailed and the ateliers of France grew in importance and reputation as the character and prestige of those of Flanders faded away, until all the latter were closed, leaving the field entirely to their French competitors. See TAPESTRIES; GOBELINS, etc.

CHARLES M. FFOULKE,
Lecturer and Writer on Antique Art Tapestries.

TAPEWORM. An elongate flattened ribbon-like parasitic worm belonging to the class Cestoda (q.v.) of the phylum Plathelminthes. In the large majority of forms the body is divided tranversely by septa into links, segments or proglottids which are usually conspicuous externally although in a few less common genera such partitions are lacking and there are rare species in which the body consists of but a single joint or section.

The tapeworms are common in all vertebrates and from their considerable size and length are the most conspicuous of all parasites. Three of the 24 species found in man are 10 meters or more in length and yet certain other species are so insignificant that they have long been overlooked. The large human tapeworms were known to the Greek and Egyptian physicians although all were regarded as of one kind and it was 1602 before the famous Basel clinician, Felix Plater, distinguished two kinds of tapeworms from man. The large bladder-worms from various domestic animals were also well known to Greek writers on medicine but were considered as growths until Redi in Italy demonstrated their animal nature. They were, however, placed in a special class (Cystici) until about 1850 Küchenmeister by feeding experiments established their relation as larval or immature forms of certain tapeworms. The proscription placed by Moses on the use of certain flesh had its ground unquestionably in the prevalence in such animals of bladder-worms. Hippocrates writes of the evacuation of pumpkin-seed-like fragments as diagnostic of tapeworm and Aristotle showed that in contrast with round worms which are free the tapeworm is attached to the wall of the alimentary canal by means of its head.

The body of a tapeworm has at one end a bulbous enlargement known as the head or scolex which in other types has a different construction but is oval with two elongate grooves in the fish tapeworm of man and more rounded with four cup-shaped suckers in the beef and

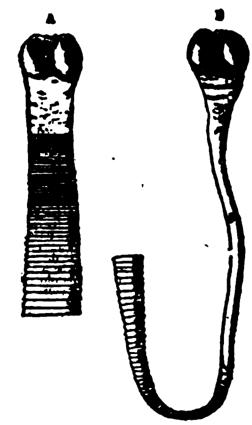

FIG. 1.— The Beef Tapeworm. A, the head; B, head and part of the body.

pork tapeworms of man. (Cf. Figs 1 and 3). Following the scolex comes a very slender region, usually undivided; this is the neck. It changes very gradually into the jointed body which becomes heavier and more conspicuously divided toward the large end where in the full grown intestinal parasites proglottids are being regularly set free and evacuated from the intestine of the host. Since the body is highly muscular and has no hard skeleton, it varies constantly and conspicuously in shape, especially at and near the scolex and neck so that the entire appearance of the anterior may be radically modified. (Fig. 1). The head may be armed with hooks as well as suckers, as in the human parasite often designated the pork tapeworm.

Most tapeworms are found in the intestine and in man this is the only normal location; the reports of their occurrence in the stomach being purely imaginary or due to reversal of the normal movement of the alimentary canal. They have been found in the bile duct and with the scolex embedded in the wall of the intestine, but all such occurrences are rare and rank as abnormal. The effect of this parasite on the host is measured first by the loss of nutriment which must be relatively great as the tapeworm is large and grows with striking rapidity. In the beef tapeworm the growth measures about 72 millimeters per diem which is equivalent to the formation of 13 to 14 proglottids daily. This factor is, however, inadequate to explain the results produced by the presence at times of only a single parasite. These symptoms are prominently of a reflex nervous character and are usually explained on the supposition that the tapeworms produce toxic substances which are absorbed by the host and induce a marked toxemia. One human tapeworm produces a severe anæmia of the pernicious type recognized as characteristic of the presence of this species.

The symptoms of tapeworm disease are rather general and not well defined so that a diagnosis must be made by the demonstration in the fæces of loose proglottids which are discharged either singly or in groups of three or four. The abundance and distribution of tapeworms are not accurately known and statistical data exist only for a few localities and for selected groups such as hospital patients, inmates of public institutions and soldiers.

Authority	Country	Dates of records	Total number of cases	Tænia saginata	Tænia solium	Dibothriocephalus	Dipylidium caninum	Hymenolepis diminuta	Indet.
Parona	Milan	1899	150	121	11	4	....	....	14
Parona	Italy	1868–99	513	397	71	26	....	....	19
Krabbe	Denmark	1869	100	37	53	9	1	....	....
Krabbe	Denmark	1869–87	200	153	24	16	8	....	....
Krabbe	Denmark	1887–95	100	89	....	5	6	....	....
Stiles	United States	1897	....	Many	Rare	3	....	1	....

The French maritime hospitals reported in 1890 about 1.5 per cent of all cases were treated for tapeworm infections and the United States hospital service during the Civil War recorded only 0.012 per cent treated for tapeworm, a record that is certainly much lower than the true degree of infection in this country.

The bladder worm, or larval stage in the life history of the tapeworm, is found encysted in the flesh of a great variety of hosts. It gains entrance to the final host when the flesh containing the cysts is ingested. When set free by digestion the bladder-worm everts the head and neck region which were formed in inverted fashion on the inside of the hollow spherical or oval larva. The bladder itself is digested but the chain of proglottids grows out from the neck.

The beef tapeworm (*Tænia saginata*), also called the unarmed tapeworm of man because the scolex is devoid of hooklets, inhabits the small intestine of man but has not been found in any other host. The bladder-worm (*Cysticercus bovis*) occurs in the muscles and viscera of cattle. As is natural from the cosmopolitan distribution of both hosts this parasite occurs over the entire world but is more common in those regions where the habit prevails of eating beef underdone or rare. It is also increasing in frequency as shown by the statistics of the French maritime hospitals which report 33 cases among 130,927 or 0.2 per 1,000 during 1861–65; and 1886–90, 2,253 were infected among 152,352, or nearly 75 times as many as at the earlier date. Attention has already been called to the head of this tapeworm which with the neck is highly muscular and variable in form. The reproductive organs are not visible except as faint strands of tissue in full grown proglottids; they have the form represented in Fig. 2. The numerous small round masses are the testes which communicate by branching vessels with the common sexual pore at the side. Generally speaking these pores alternate in successive segments. The large bush-like masses are ovaries and the slender flattened structure near the posterior margin is the yolk gland. Between it and the ovaries lies the small spherical Mehlis gland formerly known as the shell gland, but incorrectly designated as such since investigations show that the material for the shell comes from the so-called yolk gland or vitellarium. At this stage of development the uterus appears as a median sausage-shaped receptacle. When the eggs accumulate it is increased in size so greatly that numerous lateral branches are formed extending almost to

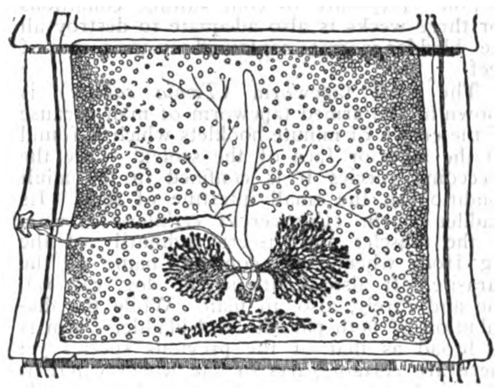

FIG. 2.—Sexual organs in a tapeworm segment (*Tænia saginata*).

the margin of the proglottid, giving the aspect shown in Fig. 3.

The segments of this tapeworm when evacuated are little more than sacs covering the much branched uterus which is crowded with eggs. They possess considerable power of independent movement and are frequently found at some distance from the point of deposit. The eggs have several coverings which

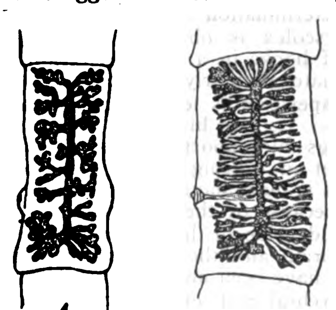

FIG. 3.—Free proglottids of *A*, *Tænia solium*, and *B*, *Tænia saginata*.

serve to protect them even after the disintegration of the proglottid. Distributed by chance an egg reaches the stomach of an ox with the food or drink of the animal. Under the stimulus of the gastric juice the membranes are ruptured and spherical six-hooked larva escape. It bores its way through the wall of the alimentary canal and comes to rest in the connective tissue. When it reaches a suitable location it develops by growth and the accumulation of a considerable amount of fluid in the centre to a bladder-worm. A thickening of the wall of the bladder produces an ingrowth in which is formed in reverse the head of the future tapeworm. Growth is slow and in six months the worm measures only six millimeters or less in diameter. If the flesh containing the bladder-worm is consumed by man while the parasite is still living the head of the bladder-worm is everted and it attaches itself to the wall of the intestine and begins to grow into a mature specimen. This period of growth requires no more than 9 or 10 weeks for the production of mature proglottids. Since a moderate temperature is unfavorable to the bladder-worm well-cooked meat cannot possibly carry the infection. Exposure to cold storage conditions for three weeks is also adequate to destroy all the bladder-worms contained in a piece of beef.

The pork tapeworm (*Tænia solium*) is known as the armed tapeworm of man because of the crown of minute hooklets which is found on the anterior face of the scolex. Like the preceding species it is confined in the adult condition to the small intestine of man. Its bladder worm (*Cysticercus cellulosæ*) occurs in the muscles and viscera ordinarily of the pig from whence the common name of the parasite. It also occurs in the dog, cat, rat, ape and rarely, also, in man. While the distribution of both parasite and bladder-worm is as broad as that of the previous species yet there are certain parts of the world where it is entirely wanting, i.e., among those people who do not eat the flesh of the pig. The species is common in European countries where pork is consumed in the smoked but uncooked condition and is very uncommon in the United States because of the general practice of eating pork well done. The parasite is somewhat more slender than the beef tapeworm. The terminal proglottids (Fig. 3) show that the branches of the uterus are less numerous and heavier than those of that species, but to distinguish between them is not always easy. A positive determination can readily be made when the scolex is obtained because of the presence of hooks in a double circle in which they alternate regularly in size. In general the pork tapeworm is less muscular and more transparent. Its life history is similar except that the eggs find opportunity for hatching and development in the pig rather than in cattle. The species is more dangerous than the preceding form because of the fact that the bladder-worm may develop in the human host. Apparently the brain and the eye are the points in which they have been more frequently observed and the cerebral cysticerci are most dangerous because they produce naturally conditions similar to brain tumors and are not infrequently the cause of sudden death. There are no special symptoms connected with their presence and usually it is not possible to distinguish between them and tumors of different origin. The bladder-worm displays in some situations a marked longevity as the same individual has been followed by means of the opthalmoscope for 20 years in the human eye. Because of the campaign against the use of pork except when well cooked this parasite has grown much rarer within recent years.

The dwarf tapeworm (*Hymenolepis nana*) is the most numerous parasite of this group found in man in North America. It is regarded by some as identical with a species that occurs in rats and mice. On account of its small size it was not discovered until the middle of the last century and while even yet it is frequently overlooked it is present at times in enormous numbers. It may justly be considered cosmopolitan in its distribution. Cases occur in general under unfavorable hygienic surroundings and infection is probably traceable to contamination of food by rats and mice. The worms are usually found in considerable numbers and excite digestive disturbances of marked severity. Diagnosis is made by microscopical demonstration of eggs in the fæces and treatment should be at the hands of a physician. The records of Ransom concerning North American cases indicate the great frequency of the parasite in children and especially in infants.

One of the smallest of tapeworms is *Tænia echinococcus* which is a parasite of the dog. The chain consists of only three or four proglottids. The parasite is important because of the character of its larva or bladder-worm which is known as an hydatid (*Echinococcus polymorphus*). This bladder-worm develops in a very large number of hosts and produces a complex structure with secondary and tertiary bladders in great numbers so that the entire mass assumes enormous proportions. Specimens found in the human host have attained a mass equal to 30 or 40 pounds. The liver is the preferred seat of the bladder worm in man and its serious character depends upon this fact because the tissues involved may be of a character to prevent surgical treatment and bring about the death of the host. In addition to the general practice of removing the hydatid by surgical means other methods of treatment have recently been tried with some success. This and numerous other parasites owe their

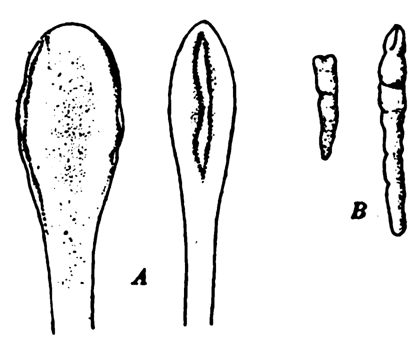

FIG. 4.—*Dibothriocephalus latus*; *A*, Scolex × 15, *B*, Larvæ from fish, in extended and contracted condition.

abundance and distribution to the frequence and movements of stray dogs.

The broad tapeworm, *Dibothriocephalus latus,* is also known as the fish tapeworm of man. The adult occurs in the small intestine of man and of the dog. The larva is found in the muscles and viscera of numerous fish: pike, burbot, grayling and trout. This is the largest common human parasite, reaching often a length of 20 meters. The head (Fig. 4) is provided with a pair of lateral sucking grooves which distinguish it readily from the other forms discussed previously. The uterus forms a rosette (Fig. 5) in the thickened centre of the proglottid and the species is recognized readily by both of these features. The para-

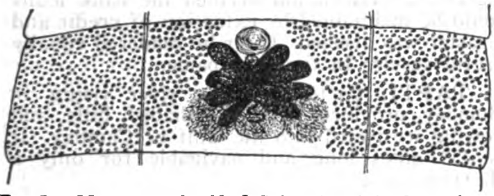

FIG. 5.— Mature proglottid of *Dibothriocephalus latus*, showing female reproductive organs. Note characteristic uterine rosette centre.

site is very abundant about the shores of the Baltic and also occurs in isolated spots as around a lake near Munich and in the vicinity of Lakes Geneva, Neuchâtel and Bienne in Switzerland. Larvæ have been found abundantly in fresh fish from markets near the Baltic and living specimens were obtained from smoked, salted and frozen fish as well as from salted roes used as caviar. The species is common in Japan and perhaps in some other parts of Asia where the larval host is said to be a salmon eaten raw as a delicacy by the natives. It has been introduced many times into the United States and seems to have established itself in small areas around certain lakes in northern Michigan, Wisconsin and Minnesota where an abundant foreign population has introduced from the Old World the habit of eating smoked fish without cooking. For further data consult Nuttall, G. H. F., ‹The Poisons Given off by Parasitic Worms in Man and Animals› (American Naturalist, Vol. XXXIII, 1899, pp. 247–49); Stiles, C. W., and Hassall, Albert, ‹The Inspection of Meats for Animal Parasites› (United States Department of Agriculture, Bureau Animal Industry, Bull. 19); Ward, H. B., ‹Cestodes in Reference Handbook of Medical Sciences› (New York 1913).

HENRY B. WARD,
Professor of Zoology, University of Illinois.

TAPIOCA, a starchy product manufactured from the rootstocks of cassava or manioc (*Manihot manihot*), which belongs to the family *Euphorbiaceæ*. The plant is a perennial herb or shrub which grows about three feet tall, bears long-petioled, deeply lobed leaves, and axillary panicles or racemes of monœcious flowers followed by three-celled capsules containing three seeds. The fleshy, cylindrical rootstocks are often three feet long and weigh 25 or more pounds. In the tropics, especially of South America, where the plant is native, manihot is extensively cultivated, and in Florida and other parts of the Southern States it is also grown. The usual practice in the West Indies is to plunge pieces of stem about 30 inches long into the ground, preferably a sandy loam, and let it care for itself, except for an occasional hoeing to kill weeds. At harvest time the rootstocks are dug, washed and rasped or grated to set the starch free. The fibre is removed as in potato-starch making, by maceration in water. The powder is then dried by heating it upon iron plates, a process which results in the familiar form of «pearl tapioca,» seen in Northern markets. Tapioca is highly esteemed for making puddings with or without fruit, etc.

TAPIR, a member of a family (*Tapiridæ*) of hoofed mammals, allied to the horses and rhinoceroses and chiefly distinguished by the fact that the nose is prolonged to form a short proboscis or trunk and the front feet have each four toes, the hind feet possessing three toes only. The little toes of the front feet are unsymmetrical and do not touch the ground, while all the toes are «hoofed.» They are adapted to live in swamps and rarely leave the dense forests covering such wet places. The tapirs possess a very wide distribution and inhabit both the Old and the New World. The best-known species is the South American tapir (*T. americanus*), which inhabits tropical America and is chiefly found living on the banks of rivers, in which it swims and dives with great ease. It is chiefly a nocturnal animal, feeding on roots, fruits and leaves. The adult is colored brown, the young being variegated with lighter spots and stripes on a darker ground. The hair is short and thick, but the neck possesses a short black mane. The average length is from four to six feet. A second species of South American tapir is the *T. villosus,* which is distinguished chiefly by the greater length of its hair, due to the fact that it inhabits elevated foot-hills of the Andes, where the climate is cold.

The only other distinct species is the Malayan tapir (*T. Malayanus* or *Indicus*), found in Malacca and Sumatra and known by the white color of the hinder part of its body, the head and anterior portions being black. The proboscis is larger in the Malayan species than in the South American forms and the former has no mane. It is usually of larger size than the New World forms and appears to be a shy, retiring animal, inhabiting clumps of brushwood.

The existing tapirs seem to approximate more closely than any other perissodactyls to the primitive (Eocene) type of that group. The family, as at present defined, dates back to the Lower Miocene and its remains are found in the White River beds of that age in the Rocky Mountain region. The earliest are separated as the genus *Tapiravus*, but typical tapirs soon appear. «It is thus evident,» remarks Woodward, «that during Miocene and Pliocene times these animals ranged over most of the warm and temperate lands of the Northern hemisphere. Hence is explained the remarkable distribution of the existing tapirs, which are confined to two widely separated areas, namely (1) certain portions of the Indo-Malayan region, and (2) the tropical parts of America. Like the surviving dipnoan fishes they are an illustration of a once dominant race nearly exterminated, but still struggling for existence where competition happens to be least severe in their particular case.»

TAPPAN, tăp'an, **Arthur**, American philanthropist: b. Northampton, Mass., 22 May 1786; d. New Haven, Conn., 23 July 1865. He accumulated a fortune in the dry-goods business in New York and became noted for philanthropy. He was a founder of the American Tract Society; founded Oberlin College, endowed the Lake Seminary in Cincinnati and aided other educational institutions. In 1828 he founded the New York *Journal of Commerce* and in 1833 established *The Emancipator*. He was an ardent abolitionist and a president of the American Anti-Slavery Society, to which at one period he contributed $1,000 a month. He aided fugitive slaves to escape from the country and procured the release of William Lloyd Garrison when the latter was imprisoned in Baltimore, by paying his fine.

TAPPAN, Benjamin, American naval officer: b. New Orleans, La., 10 April 1856. He was graduated from the United States Naval Academy 1876 and in 1886 was commissioned lieutenant. From 1888–91 he served in the office of the Bureau of Naval Intelligence and from 1891–94 on the *Miantonomah*. He was stationed at the Brooklyn navy yard 1895–96 and while on board the *Raleigh* participated in the battle of Manila (1898). During the attack on the city of Manila he captured a Spanish battery and for this act was advanced five numbers by President McKinley.

TAPPAN, Eva March, American educator and author: b. Blackstone, Mass., 26 Dec. 1854. She was graduated from Vassar College in 1875 and was a Fellow of the University of Pennsylvania 1895–96. She has published 'Charles Lamb, the Man and the Author' (1896); 'In the Days of Alfred the Great' (1900); 'Our Country's Story' (1902); 'In the Days of Queen Victoria' (1903); 'Canada's Story' (1903), etc.

TAPPAN, Lewis, American merchant and philanthropist: b. Northampton, Mass., 23 May 1788; d. Brooklyn, N. Y., 21 June 1873. He spent several years in commercial life at Boston, then (1827) settled in New York as partner of his brother, Arthur. Both took a very active part in the anti-slavery cause. Lewis and his brother were among the founders of the *Journal of Commerce* (1827) and (1828–31) Lewis was sole proprietor. The pro-slavery mob, in 1834, sacked his residence. He aided in the organization of the American Missionary Association, acting as treasurer and president for a number of years. His firm failed in the crisis of 1837, but later met all indebtedness. After the failure he established the first mercantile agency in this country and remained its head for a number of years. He published his brother Arthur's 'Life' (1871).

TAPPAN BAY, or **TAPPAN SEA**, the names given to the expansion of the Hudson River near Ossining and Tarrytown, N. Y. See HUDSON RIVER.

TAPPEN, Frederick Dobbs, American financier: b. New York, 29 Jan. 1829; d. Lakewood, N. J., 28 Feb. 1902. He was educated at Columbia Grammar School and New York University, graduating in 1849. Next year he entered the National Bank of New York as clerk, rising, by 1857, to cashier. The bank was reorganized (1865) as the Gallatin National and Tappen became president in 1868. He became member of the conference committee with the New York Clearing House in 1869 and member of the committee in 1872 and was appointed (1873) member of a committee to suggest financial reforms in operations between banks. Then and later he brought about clearing-house reforms in practice to this day. In the 1893 crisis Tappen rendered most important service; by June business was paralyzed and business corporations, banks, railroads, etc., had a $2,000,000,000 liability with gold in the treasury at low ebb, but the Clearing-House Association decided the bank loans could be maintained by extension of credit and disaster was averted. Later he rendered equally useful service in times of panic.

TAPTI, tăp'tē, India, a river rising in Bombay province in the Mahadeo hills and flowing westward into the Gulf of Cambay. It is 430 miles long and navigable for only a short distance.

TAPUL, tā-pool', a group of islands of the Sulu Archipelago, Philippines, lying between the Sulu group on the northeast and the Tawi Tawi group on the southwest, consisting of 38 charted and named islands and some unnamed islets; area, 77 square miles. The more important islands of the group are: (1) Siasi (q.v.), the largest, in the southern part of the group; (2) Bolipongpong, the most northwesterly of the group, heavily wooded; elevation, 955 feet; area, eight square miles; (3) Lapac, west of Siasi, from which it is separated by a narrow channel, with a very rugged surface; highest elevation, 1,344 feet; area, seven square miles; (4) Tapul, the name island, the most northerly of the group, fertile and under cultivation; highest elevation, 1,636 feet; area, six square miles. Though all tropical products and vegetation flourish in the larger islands, the chief industry is mother-of-pearl, pearl and turtle fishing; there are cocoanut plantations of value on one of the islands. Trade is carried on with Sulu, Tawi Tawi and Borneo. Pop. (estimated) 3,000. See SULU.

TAR, a thick, very dark liquid obtained by the dry destructive distillation of various organic substances. That obtained from coal, peat, bituminous shale, etc., is called coal-tar, while that from wood is named wood-tar. They are both very complex mixtures of organic substances. The substance popularly known as tar is wood-tar.

Coal-tar is collected from the hydraulic main and condensers of the gasworks as a black, oily, bad-smelling liquid somewhat heavier than water. It was formerly considered useless and a great nuisance, but, since the discovery of the value of its constituents, it has been made the starting material in many important industries. Coal tar is a very complex mixture of hydrocarbons, acid and basic bodies. Its components are first separated in a rough way by fractional distillation and then each fraction is subjected to an extensive chemical treatment to separate and purify each substance therein. The hydrocarbons occur in largest proportion and they are the most valuable. Some of the important ones are benzene (or benzol), toluene, xylene and anthracene. Of the acid bodies phenol or carbolic acid is the most important. The value of these substances lies not in themselves but in the compounds to which the chemist may pass from them. Nearly all of the varied and beautiful dye-stuffs now used are obtained from the substances mentioned above. The coal-tar colors are of exceeding brilliancy, but many are lacking in permanency (see DYEING).

Wood-tar is a thick, dark colored, viscous material, obtained as a by-product in the destructive distillation of wood in the manufacture of pyroligneous acid (wood vinegar) and methyl alcohol (wood alcohol). It varies somewhat in character with the kind of wood used. Wood-tar has many ingredients in common with coal-tar. The hydrocarbons mentioned above are present in small quantities; small amounts of carbolic acid are found with much larger quantities of homologous substances, the cresols (the whole mixture being called creosote). Products arising from the pyroligneous acid and methyl alcohol are also found, such as acetone, methyl acetate, etc. Wood-tar is prepared in large quantities in northern Europe by a very crude and wasteful process. A hole in the ground or side hill is lined with turf and then filled with wood (usually of coniferous trees), which is afterward nearly covered with turf. The wood is burned slowly with little access to air. The tar collects in the bottom, being usually caught in an iron pan provided with an exit tube. Wood-tar has valuable antiseptic properties because of the creosote it contains. This is often separated, but the wood-tar itself is much used for coating and preserving timber in exposed places.

Tar is a stimulant and antiseptic to the skin and mucous membrane. It is used externally for skin diseases in an ointment, lotion or soap. It is found in many cough mixtures and its vapor is frequently inhaled for pulmonary troubles.

TAR HEEL STATE, a popular nickname applied to North Carolina (q.v.).

TARA, tä'ra, Ireland, a hill in County Meath, six miles east of Trim. According to tradition the *fes of Tara*, the triennial convention here, was established by Ollam Fodlah or Ollav Fola (B.C. 900 or 950). After the decisions of the meeting the princes and others present held a banquet, each guest seated beneath his shield which the heralds had suspended on the walls of the great hall. The palace of Tara, tradition says, was 900 feet square and had 150 apartments and 150 dormitories. The hall had a capacity for entertaining 1,000 guests daily. It was here the early kings of Ireland were crowned. King Cormac Mac Art (3d century A.D.) is said to have founded schools here of military science, law and literature. In the days of Saint Patrick, Tara is said to have been the principal seat of Druidism and idolatry and (about 560 A.D.) fell under the curse of Saint Ruadan and had to be abandoned as a royal residence. A battle here is said to have caused the fall of Danish rule in Meath in 980. In 1798 the Royalist troops, 400 strong, defeated 4,000 Irish insurgents, killing 500. Daniel O'Connell held a monster meeting here 15 Aug. 1843, at which it is said 250,000 persons attended. The so-called remains of the royal palace are represented by six *raths* or circular earthworks, of which the *rath-na-riogh* (king's rath), which is the most extensive, contains the *forradh* (meeting place) which consists of an elevation having a level summit. The "stone of destiny," on which the kings are said to have been crowned, is located here. Certain earthworks enclosing a space about 759 feet by 46 feet and having breaches at intervals supposed to have been the entrances are considered as having been the banqueting hall. Thomas Moore rendered the Tara tradition imperishable with his poem "The Harp That Once Through Tara's Halls."

TARAI, tä-rī, or **TERAI**, India, a moist, jungly and unhealthful tract of land running for several hundred miles along the southern base of the central Himalaya. See HIMALAYA.

TARANTELLA, a swift, whirling Italian dance; so-called because it was popularly thought to be a remedy against the supposed poisonous bite of the tarantula spider, which was said to set people dancing.

TARANTISM, or **TARANTISMUS**, dancing disease (q.v.).

TARANTO, tä-rän'tō (Latin, *Tarentum;* Greek, *Taras*), southern Italy, a city in the province of Lecce, at the northern angle of the Gulf of Taranto, on a rocky tongue of land which separates the ancient inner harbor, a sort of lagoon called the Mare Piccolo (Little Sea), on the east, from the open sea on the west. The side has been made an island by a canal on the southeast, crossed by an iron swing-bridge, which admits the largest war vessels; another bridge at the northwest end also connects it with the mainland. Two islands, Saint Paolo, with a fort and a lighthouse, and Saint Pietro, guard the entrance to the outer harbor. The streets are very narrow, the three principal being the Strada Garibaldi along the Mare Piccolo, inhabited chiefly by fishermen; the Strada Maggiore, in the heart of the town, the main business thoroughfare; and the Strada Vittorio Emanuele, along the sea-front, a fine promenade. The 11th century cathedral, now wholly modernized, and the old castle are the chief objects of interest in the town proper. The Borgo Nuovo, a suburb on the mainland to the southeast, occupying the site of ancient Tarentum, contains a large arsenal and naval hospital and various harbor works have been constructed. The fortifications of the town have been much strengthened since 1895. There is an export trade in oil, wine, licorice, fruit, etc.; and coals, grain, petroleum, etc., are imported. Tarentum was founded by Greeks in 707 B.C., and rapidly became the chief city of Magna Græcia. It was noted for weaving and for the purple dye obtained from a species of mussel. It reached its greatest prosperity under Archytas, the philosopher, in the 4th century B.C., after which luxury and vice caused it to decline. It was compelled to seek the assistance of Greek kings in its wars with the Lucanians and when attacked by the Romans it was assisted by Pyrrhus of Epirus. In 272 B.C., however, it was taken by the Romans and the conquest was repeated in 209, after the city had supported Hannibal in the Second Punic War. It passed later under Byzantine sway, was destroyed by the Saracens in 927 A.D. and later belonged to the Norman kingdom in South Italy. In 1861 it became included in the kingdom of Italy and the Italian government strongly fortified the place, establishing there a torpedo base. It is now one of the four important naval centres of Italy. Pop. about 56,000.

TARANTULA, a large spider (*Lycosa tarantula*) with a body about an inch in length; its bite was formerly supposed to produce a kind of frenzy in human subjects called tarantism. The nervous actions of those victims are supposed to be imitated in the wild musical dance known among the Italians as "tarantella." Doubtless in some cases its bite produces disagreeable symptoms. The species named is a native of Italy, but varieties, or closely allied species, are found throughout the south of Europe. The so-called tarantulas of Texas and adjacent countries are large species of *Mygale*.

TARANTULA-KILLER, a very large burrowing wasp (*Pompilus formosus*) of Texas and southwestward, which stings tarantulas, depositing its eggs in their bodies and carrying the paralyzed spider off to its nest. See WASPS.

TARAPACA, tä-rä-pä-kä', Chile, a province in the northern part of the country, between Bolivia and the Pacific Ocean. Area, 16,689 square miles. The main range of the Andes forms the eastern boundary, while a lower range runs along the coast. The entire intervening country is a rainless desert traversed by a few streams in narrow valleys. The importance of the province lies in its immense deposits of nitrate of soda. These are found in the interior deserts and railroads are built from the coast to reach them. There are also some silver mines in the coast range. The capital and chief port is Iquique. The province was occupied by Chilean troops in 1879 and was ceded to Chile by Peru by the Treaty of Peace in 1883. Pop. 125,961.

TARASCO, an ancient tribe of American Indians which formerly spread over all of the Mexican states of Michoacan, in Guanajuato and Quaretaro. The Tarascos have been absorbed largely in the half-breed population, but Lumholtz states that he came across the pure stock nearly 200,000 strong, in 1896, still living in the mountains of Michoacan. According to their traditions they must have come from the northern regions, as did the Nahuatlans. They do not call themselves Tarascos but name their tribe *Purépecha*. In consequence of their absorption with other races their original customs, in most sections, are fast disappearing, They never mention the sun except as Our Father Sun and they transact no business nor will they shell corn after sun-down. They worshipped the Southern Cross constellation. In each house they place in the best room pictures of a saint or saints, which are said to inhabit that room, while they, out of reverence to the saint, sleep in the kitchen; but they allow strangers to occupy that room. The entire series of their saints is called *Tata Dios,* Father God. Copal incense is burned before the house deity, and the visitor, before mentioning the cause of his arrival, first kisses the saint's picture. The tribe has a great love for music and almost every individual has his guitar. They are hard workers, especially the women, who are badly treated. Like most Indian tribes, the Tarascos are clever potters. Consult Lumholtz, K. S., 'Unknown Mexico' (New York 1902).

TARASCON, tä-räs-kôn, France, a town in the department of Bouches-du-Rhône, on the left bank of the Rhône, opposite Beaucaire, with which it is connected by a suspension-bridge, 55 miles north-northwest of Marseilles. It is surrounded by walls, flanked with towers and entered by three gates. The streets are wide and regular and one of them is lined with arcades. The principal buildings are the old castle, seated on a height overhanging the river; the church, a handsome Gothic structure of the 11th century, with a finely sculptured portal; the town-house, courthouse, theatre, general hospital and public library. Woolen cloth, serge, silk goods, hempen and cotton cloth, vermicelli, soap, starch and cordage are manufactured and there are also brandy distilleries, wax refineries, tanneries, brickworks and building-yards for barges. The trade is in wine, brandy, oil, hemp, wool, wood, coal, medicinal plants, lucerne-seed and madder. Tarascon is the Roman Tarasco and is an interesting type of the mediæval town. It is the locale of Daudet's 'Tartarin de Tarascon.' Pop. 8,631.

TARAXACIN, a crystallizable substance found by Pollex in the milky juice of the root of the ordinary dandelion. It is bitter and acrid in taste. Used somewhat as an alterative and tonic.

TARBELL, Edmund C., American artist: b. West Groton, Mass., 1862. He was a pupil in the Boston Museum of Fine Arts and going to Paris was taught by Boulanger and Lefebvre. In 1900 he took the Clark prize at the National Academy of Design; the Shaw Fund, Society of American Artists (1893); medal at the Columbian Exposition and other awards at Philadelphia, Boston and Paris (bronze medal 1900). In 1906 he was elected to the National Academy. For many years he was instructor at the Boston Museum. His pictures are distinguished by fine atmosphere and color and the bold truthfulness of his outdoor work borders on impressionism.

TARBELL, Frank Bigelow, American archæologist: b. Groton, Mass., 1 Jan. 1853. He was graduated at Yale in 1873 and was assistant professor of Greek and instructor of logic there 1883–87 and was instructor of Greek at Harvard University 1889–92. He has been professor of classical archæology in the University of Chicago from 1894 and has published 'The Philippics of Demosthenes' (1880): 'A History of Greek Art' (1896): 'Catalogue of Bronzes, etc., in Field Museum of National History' (1909).

TARBELL, Ida Minerva, American biographer: b. Erie County, Pa., 5 Nov. 1857. She was graduated from Allegheny College, Meadville, Pa.; was associate editor of *The Chautauquan* 1883–91; studied at the Sorbonne and Collège de France, 1891–94; from 1894 to 1906 was on the editorial staff of *McClure's Magazine;* from 1906 to 1915, associate editor of *The American Magazine*. Her publications include a 'Short Life of Napoleon

Bonaparte' (1895); 'Life of Madame Roland' (1896); 'Early Life of Abraham Lincoln' (with J. M. Davis, 1896); 'Life of Abraham Lincoln' (1900); 'History of the Standard Oil Company' (1904); 'He Knew Lincoln' (1908); 'Father Abraham' (1909); 'The Tariff in our Times' (1911); 'The Business of Being a Woman' (1913); 'The Ways of Women' (1915); 'New Ideals in Business' (1916); 'Making Men at Ford's' (1916).

TARBES, tärb, France, capital of the department of Hautes-Pyrénées, 25 miles east of Pau, on the Adour, here crossed by a handsome bridge. The cathedral is a modern structure, erected on the site of the old castle of the counts of Bigorre, of whose territory Tarbes was the capital; other buildings are the church of Saint John, the church of the Carmelites, with a remarkable spire; the prefecture, occupying the old episcopal palace; the civil hospital, college and barracks. Leather and paper are manufactured and the trade includes, in addition to these articles, wine, iron, cattle and agricultural produce. Tarbes is mentioned by Cæsar under the name of Bigorra. A famous battle was fought here 20 Nov. 1814, the English routing the French. Pop. of the commune, 28,615.

TARDE, tärd, **Gabriel,** French philosopher: b. Sarlat, Dordogne, 1843; d. Paris, 1904. He studied law, became *juge d'instruction* in his native town and held this position for nearly 19 years. He began his contribution to the *Revue Philosophique* in 1880 and between 1882 and 1884 published in it his first studies of the law of universal repetition and imitation. In 1894 he was called to Paris to assume control of the Bureau of Statistics of the Ministry of Justice. He relinquished this post in 1900 and became professor of modern philosophy in the Collège de France; in that year, also, he was elected to the Institute of France. His writings deal largely with the laws that govern mankind in their social relations; how new ideas are brought out, developed and are accepted as custom. He was a thorough believer in the theory that 99 men are imitators to one original. His studies in criminology contain similar views. His publications, several of which have been translated into English, include 'Les Lois de l'Imitation' (1890); 'La Criminalité comparée and La Philosophie pénale' (1891); 'La Logique sociale' (1895); 'L'Opposition universelle' (1897) and 'Les Lois sociales' (1898); 'Essais et Melanges Sociologiques' (1895); 'L'Opinion et la Foule' (1901); 'Psychologie Économique' (1901); 'Underground Man' (1905). Consult 'Gabriel Tardi,' with preface by Bergson (1909).

TARDIEU, tär'dyė, **André Pierre Gabriel Amédée,** French publicist and administrator: b. 22 Sept. 1876. He passed out first in his year from the Ecole Normale and entered the diplomatic service, being attached to the French embassy in Berlin in 1897. He served a while in the Foreign Office and as secretary in the presidency of the Council of Ministers 1899–1902. He was editor of the *Revue des Deux-Mondes* and became foreign editor of the *Temps.* He paid a visit to the United States in 1908 and recorded his impressions of that country in a book, 'Notes sur les Etats-Unis' (Paris 1908). Of President Roosevelt, whom he interviewed, he wrote then, «What particularly characterizes his policy is its essential and emphatic Americanism,» an estimate corroborated by all Americans on the death of that statesman 11 years later. M. Tardieu entered politics in the general election preceding the outbreak of the war. He was made chief censor, a post he soon left for active service in the trenches. Incapacitated by a severe attack of pneumonia, brought on by exposure, he was appointed head of the French commission to the United States in 1917. He labored at Washington and elsewhere for the business efficiency of the Allies and the co-ordination of their economic strength. Returning to France shortly after the formation of the Clemenceau ministry, he later made another important trip to America and subsequently remained in Paris as high commissioner for all matters concerning France and the United States. He was the youngest delegate to the Peace Conference in Paris. He wrote several excellent books on European politics; his 'Questions diplomatiques de l'année 1904' was «crowned» by the French Academy. A remarkable work is his 'Le Mystère d'Agadir,' dealing with Morocco and Germany. He also wrote 'La Conférence d'Algesiras' and 'France et les Alliances' (Paris 1907).

TARDIGRADA, tär'dĭ-grā'dą, a term in zoology applied (1) to the group of sloths and (2) to a group of microscopic animals also known as water-bears, which are usually classed with the *Arachnida.* The water-bears have a cylindrical body bearing four pairs of short clawed feet, while the mouth is furnished with two stylet-like rods. The nervous system is much like that of annelids; circulatory and respiratory organs are lacking. These animals are hermaphrodic, and when the eggs are fertilized the skin of the body is shed, the eggs remaining in it. The development is more like that of the annelids than like that of the arachnids, and the relation of these animals to the spiders is more than doubtful. The species all live in fresh water, being common in moss and fresh-water algæ. Most of the species will stand prolonged drying and will revive upon being placed in water.

TARDIVEL, tär'dē-vĕl, **Jules Paul,** Canadian journalist: b. Covington, Ky., 1851; d. 1905. He went to Canada in his 17th year and was educated at Saint Hyacinth College. He entered the service of *La Minerve* and *Le Canadien* and (1881) established *La Verité* of Quebec, being its editor as well as proprietor for a lengthy period. As a staunch Catholic he propagated the creed in political matters, opposing liberalism and Freemasonry. He was an advocate for entire independence of the province of Quebec and secession from the Canadian Confederation. He wrote 'Vie du Pape Pie IX, ses œuvres et ses douleurs' (1878); 'Notes de voyage' (1890); 'Pour le patrie' (1895), a novel attacking Freemasonry.

TARE, any of several plants. The tare mentioned in the Bible (Matt. xiii, 25) is supposed to be darnel (*Lolium temulentum*), since the Greek word ζιζάνια («wild rice») is used in the oldest Greek manuscript. Darnel is related to the wild rice and eating its seeds was formerly supposed to produce stupefaction. The modern tares are all members of the family *Fabaceæ*. The name is most commonly used for *Vicia sativa*, better known in England and America as the common vetch. This plant is cultivated to some extent in Europe because it will thrive upon poor soils and produce forage where other plants usually fail. Its yield is small, but in such places is deemed worth while. It is also used as a green manure for improving poor land. Its close relative, the wild vetch (*V. hirsuta*), also loosely called tare, is similarly named and used, but it is more often ranked as a weed.

TARE, in commercial technology, is an allowance for the outside packages of goods which cannot be packed without detriment, which is deducted from the weight if he buys by the pound. Obviously the papers, threads, bands, etc., that enclose or bind any goods imported loose cannot be conveniently separated for weighing nor, in many cases, can casks or chests be weighed separately from their contents.

TARENTUM, ta-rĕn'tŭm, Pa., borough in Allegheny County, on the Allegheny River, and on the Pennsylvania and the Allegheny Valley railroads, about 20 miles northeast of Pittsburgh. It is in an agricultural and coal mining region. The chief manufacturing establishments are paper mills, glass factories, foundries, machine shops, flour mills and planing mills. It is a typical manufacturing town and its 65 factories turn out about $3,000,000 in products annually. There are banks and newspapers. The educational institutions are a public high school, public and parish elementary schools and a public library. Pop. 7,414.

TARENTUM. See TARANTO.

TARGUM, the translation of the Old Testament Scriptures into Aramaic. This version originated at a time when Hebrew had given way to Aramaic as the popular language of the Jews. The need of explaining the old Scriptures to the people after their subjugation by the Persians is suggested by Nehemiah viii, 8, where we read that Ezra read the law to the people, while it was interpreted by his assistants, interpreters — Meturgemans as they were called. As the Targum was not committed to writing, little of it has survived. There are indeed three Targums of the Pentateuch and one of the Prophets, as well as of the Psalms, Job, Proverbs, the Song of Songs, Ruth, Lamentations, Esther and Ecclesiastes. The Targum is not of much critical value, but throws considerable light on the life of the Jews at the time it was composed. Consult Berliner, A., 'Targum Ontales' (Berlin 1884); Lagarde, 'Prophetæ Chaldain' (Leipzig 1872).

TARIFF. The taxation of goods by the imposition of customs duties upon passing the national boundary line or some fixed point is an ancient method of raising revenue. The earliest form of this tax was probably the transit duty imposed on goods passing through a district and was justified as a payment for protection or for special facilities. The export duty, levied on goods as they leave the taxing territory, came next in historical order. What in fact could be more just, it was thought, than a tax upon goods of whose use the home community would be deprived and the burden of which would be borne by the foreign consumer. Finally there developed import duties which are made use of in practically every civilized state to-day. Transit duties have disappeared as a form of national finance; export duties are of fiscal importance to-day only in Turkey and India. But import duties contribute a large though variable proportion of the revenues of the United States and of the leading European states. In the United States before the imposition of the income tax they made up nearly one-half of the Federal receipts; before the European War they constituted about one-half of the net receipts of the German Empire; about one-quarter of the total revenues of England; and about 15 per cent of those of France and Italy.

Among the civilized nations of antiquity tariffs for revenue purposes were generally used. The Greeks, and more especially the Athenians, levied customs duties upon both imports and exports, the usual rate being about 2 per cent. The Roman state also resorted regularly to this form of taxation. With the breakdown of centralized government during the Middle Ages the feudal lords claimed the right of imposing transit duties on all goods passing through their domains, nominally as a payment for protection. When feudalism in turn gave way to strong monarchies the rights of the lords in this regard were exercised by the kings and to local tariffs were added national ones. Every European country was covered with a network of customs lines which greatly hindered trade, but were not productive of commensurate revenues. The history of modern tariff legislation has been the simplification of this complicated system.

In England a complex system of import and export duties had slowly developed by the constant addition of new objects of taxation and by the confusing practice of assigning the proceeds of each new duty to a different purpose or fund. In 1787 Pitt consolidated all of the tariff duties into one general fund. At this time about 1,200 articles were subject to import duties and about 50 to export duties. The next step in the direction of simplification of the tariff was effected in 1824 by Huskisson, who abolished most of the export duties, freed raw materials of their burdens and consolidated a mass of tariff acts. The real beginning of modern English free trade was made during the period 1842–60, when some 938 articles were placed on the free list. Practically the only articles upon which import duties were collected after 1860 were sugar, cocoa, coffee, chicory, dried fruit, tea, tobacco, wine, beer and spirits. In spite of the decrease in the number of dutiable articles the revenues from the few remaining ones steadily increased, with a corresponding reduction in cost and simplification of administration. With the increasing competition of German and American manufactures, especially since about 1900, a reaction in favor of protection has arisen in some quarters. Since the outbreak of the European War this movement has taken the form of a demand for preferential treatment of the colonies.

In France the diverse and multifarious provincial tariffs were swept away in 1790 and the following year a common and uniform tariff against foreign countries was established. For the first time France now had economic unity. Duties were at first moderate, but under Napoleon they were made highly protective, a system which was continued under the Restoration and extended to agriculture as well as manufactures. Under the monarchy of Louis Philippe the government was administered in the interest of the middle class and consequently no changes were made in this policy. But with the establishment of the empire a more liberal policy was introduced which culminated in the Commercial Treaty of 1860 with England. By 1881 the pendulum had swung in the other direction again, and the new tariff of that year was much more protective. A decade later protection was extended to agriculture and since that time France has maintained a policy of all-around protection and national self-sufficiency.

Germany's tariff policy has moved along somewhat different lines. At the beginning of the 19th century the present German Empire was a group of mutually antagonistic states so far as their tariff relations were concerned. The great problem was to unite them under a common external tariff and to abolish the local interstate tariffs. This was finally accomplished under the leadership of Prussia by the Zollverein, which continued from 1834 to the establishment of the German Empire in 1871, when complete economic unity was effected. The tariffs under the Zollverein had been moderate and now they moved still further in the direction of free trade, but in 1878 a change was made to protection which has since been carried further, covering agriculture as well as manufactures. The tariff has been made to serve political ends as well as industrial and fiscal purposes in Germany.

In the United States customs duties have been used from the earliest colonial period. Nearly every colonial assembly levied import duties for its own treasury in addition to those imposed by Great Britain in the execution of the Navigation Acts. They seem to have been levied for sumptuary, retaliatory or protective purposes quite as much as for fiscal ends. These colonial tariffs have been classified under the following four heads: (1) tonnage duties or taxes on shipping; (2) export duties on tobacco and other colonial staples; (3) import duties on slaves; (4) regular tariff schedules in which wines and liquors were the most prominent items. These duties were generally low ad valorem duties ranging from 1 to 5 per cent, but even with these rates seem to have been largely evaded.

A national tariff act was made possible by the adoption of the Constitution and the first piece of legislation by Congress was the passage on 4 July 1789 of such an act. The main purpose of this was revenue, but protection was also extended to certain industries which it was desired to encourage, as glass and earthenware. The average rate of duty, however, was low, being about 8½ per cent, but in those days distance was a more effective barrier than it is to-day. No important changes were made until the Act of 1816, but in the meantime the Embargo and Non-intercourse acts and the War of 1812, which had interrupted foreign trade, had called into being manufactures of which it was now felt care should be taken. Accordingly this tariff act gave a substantial measure of protection to those industries most exposed to foreign competition, namely, textiles, hats, cabinet wares, leather and paper. By 1824 other industries were demanding protection such as iron, wool, hemp, glass and lead and a general revision was made in the tariff, resulting in a raising of rates throughout the list but especially in the case of the articles named. For the next few years there was continuous agitation of the tariff question, led by the woolen manufacturers who wished further protection. A convention of the friends of protection was held in Harrisburg in 1827 and systematic propaganda was carried on. The result was the tariff of 1828 which granted the highest protection yet accorded in any act, the chief beneficiaries being the cotton and woolen industries. This "tariff of abominations," as it was called, caused intense opposition both in the North and in the South, and it was replaced in 1832 by a more moderate act which eliminated the worst features of the previous tariff and put the duties back at about the point where they were in 1824.

The opposition of the South, however, was too great to be appeased by any half-way measures and in the next year it flamed out in nullification. South Carolina declared the Tariff Acts of 1828 and 1832 null and void and not binding upon the State or its citizens. In order to placate the opponents of protection and at the same time prevent too sudden and radical a revision of duties, Clay introduced the so-called Compromise Tariff of 1833. This provided for a gradual reduction of all duties over 20 per cent to a 20 per cent level by an annual excision of one-tenth per cent until 1842 when they were all to be placed at that point. This agreement was carried out and the reductions took place according to schedule. Hardly had this been effected, however, than the protectionists seized upon the decline in revenues which had followed the panic of 1837 as an excuse for another revision of the tariff, this time in the direction of much higher duties; in general, the Act of 1842 returned to about the level of the Act of 1832. By 1846 good times had returned, there was a surplus in the treasury and a Democratic President and Congress were in office. They decided to make a radical change in the tariff policy which they enacted into law in the Act of 1846. This has often been called a free trade tariff, but it still retained a considerable protectionist flavor although the rates on the great bulk of commercial products were reduced to between 15 and 30 per cent. The next few years were years of unparalleled business prosperity and commercial expansion and the revenues from import duties increased by leaps and bounds. The need of a reduction of revenue was so obvious that in 1857 another tariff measure was enacted lowering many of the duties and enlarging the free list. Before this act was fairly in effect, however, the panic of 1857 cut down importations to such an extent that a deficit resulted and accordingly in 1861 the previous duties were restored.

When the Civil War broke out the necessity for revenue outweighed all other considerations. Heavy excise duties were placed upon domestic manufactures and to compensate these the import duties were raised correspondingly and in some cases a little more. This was done in 1862, the average rate being raised to 37 per cent. The same procedure was followed again in 1864 except that a somewhat greater amount of protection was granted, the average rates being increased by this act to 47 per cent. After the war efforts to reduce the tariff to the ante-bellum basis met with resistance from the protected interests and practically nothing was done until 1870. In that year the duties on articles like tea, coffee, wine, sugar, molasses and spices, which did not affect domestic industries, were reduced. Again in 1872 a general revision was avoided by making a 10 per cent horizontal reduction of all duties and abolishing entirely those on tea and coffee and a few other articles. The loss of revenue resulting from the sacrifice of duties, amounting to about $20,000,000 from tea and coffee, and the shrinkage of other receipts as a result of the panic of 1873, resulted in a deficit of about $50,000,000 and in 1875 the 10 per cent horizontal reduction was repealed. The period of depression came to an end about 1878 and with the return of prosperity a surplus began to heap up in the treasury again. In 1882 a tariff commission was appointed to propose changes, but their recommendations for a reduction of the tariff were rejected by Congress. Internal revenue duties were abolished or reduced, but the import duties were on the whole increased.

This action called forth strong protest from the Democrats, and in 1887 President Cleveland brought the issue to a head by a vehement message urging tariff reform and the necessity of reducing the surplus. Up to this time the surplus revenues had been applied to the payment of the debt, but all available bonds had now been paid. The Democratic House passed the Mills bill providing for a general reduction of the tariff, but the Republican Senate replied by proposing further cuts in internal revenue duties. In the ensuing elections the Republicans were victorious and proceeded to solve the problem of the surplus by the double process of spending it and raising the import duties by the McKinley Act so as to discourage importations. Extravagant pension legislation was inaugurated and a bounty of two cents a pound given to domestic sugar producers; at the same time imported sugar was admitted free, thus sacrificing an annual revenue of $56,000,000. These actions effectually removed the surplus and indeed paved the way for a deficit, which occurred when the panic of 1893 broke upon the country. The Democratic tariff of 1894 reduced the duties on many protected commodities, added to the free list, restored the duty on sugar and provided for an income tax. The failure of the income tax section, however, by being declared unconstitutional, and the continuing depression led to embarrassing deficits, and when the Republicans were returned to power in 1896 they promptly reversed this policy by the passage of the Dingley Tariff in 1897, raising the general average of duties to the highest point since the Civil War, namely, 57 per cent. This was an increase from 37 per cent in 1883 and 49.5 per cent in 1890.

The tariff now remained undisturbed for 12 years, but dissatisfaction with the existing duties grew strong, especially with the burdens on raw materials and the favors to monopolized industries. Efforts were made within the Republican party itself, especially by members representing the Middle West, to secure a revision of those duties favorable to the trusts, though without success, but finally in 1908 a campaign pledge was made by this party to revise the tariff. The Payne-Aldrich Tariff of 1909 was an attempt to redeem this pledge, but the protected interests succeeded in preventing any serious reductions in schedules. This repudiation of party pledges led to an insurgent movement which found expression in the Progressive party and swept the Democrats into power at the next election. The Underwood Tariff of 1913 made important changes, especially in the iron and steel schedules; free wool was provided for, a gradual reduction of the sugar duty with ultimate free sugar, and in general free raw materials for manufactures. The outbreak of the European War the following year necessitated the suspension of the reduction of sugar duties, thus saving a revenue of some $45,000,000 a year. The enormous revenues needed to defray our expenditures since the entry of the United States into the war have been provided, as in the case of the Spanish War in 1898, by increasing the internal revenue taxes and by income, inheritance and excess profits taxes. An expert tariff commission was provided for by the War Revenue Act of 8 Sept. 1916, which it is expected will supply the machinery and the information for the scientific solution of the difficult problems of tariff adjustment after the war.

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ERNEST L. BOGART,
Professor of Economics, University of Illinois.

TARIFF ADMINISTRATION IN THE UNITED STATES. The administration of the tariff laws, which comes within the province of the Treasury Department, is directly under the care of the Secretary of the Treasury and one of his assistant secretaries. The machinery furnished by the department and the government for its execution is comprehensive, complicated and far-reaching. All articles imported must follow a certain prescribed and unchangeable routine which begins with the requirement of a certificate of value made before a United States consular office abroad, for every shipment of foreign merchandise destined for entry into the United States. The exact methods of entry of goods, the valuation of the same, their classification and the rate of duties to be paid, in each case, are minutely and exhaustively prescribed; and provision is made for appeal against the interpretation of the Tariff Law, the classification of articles, the tariff charges or duties and, in fact, any other injustice or irregularity that may arise in connection with the administration of the tariff. This system of appeal is very elaborate and is at the service of the importers and the government alike. Naturally the tariff administration takes charge of the collection duties. This it does directly notwithstanding the fact that the extent and importance of the import duties would seem not only to justify but to demand, as in the case of the internal revenue, a separate customs bureau. The division of the country into customs districts facilitates the collection of customs through the various ports of entry. These ports of entry are themselves subject to strict routine regulations and are provided each with an administrative staff adequate to its needs. This staff, in the larger and more important ports of entry, includes a collector, appraiser, surveyor, gaugers, inspectors, a naval officer and officials in accordance with the importance of the port. By law no goods destined for import into the country may be presented at any other place than one of these ports of entry, where the government has provided for the storage and warehousing of goods for the moment or for longer periods of time in case the importer should not wish to make use of the goods imported. The latter may defer the payment of duties, if he so desire, until it is convenient for him to take the goods out of the warehouse. The unloading of all goods destined for importation must be done under the supervision of the customs officials and accomplished within a certain specified time. This is facilitated by the requirement which exacts from every vessel arriving at a port of entry, from a foreign country, a manifest of the nature of the cargo, the names of the consignees, ports of shipment and other information of a like nature, which must be submitted to the revenue officers before reaching the dock, if so desired, and delivered to the collector, upon reaching port, in order to secure his permit to take possession of the cargo, upon the presentation, by the consignee, of a complete and detailed statement of the value and nature of the goods. This statement or invoice forms the basis on which the duty is fixed by the appraisers and the port collector. In case the consignee is dissatisfied with the appraisement, a new one may be ordered, or, in case this is denied at the port, an appeal may be made to the board of general appraisers for a reconsideration of the valuation. The United States Court of Customs Appeals handles appeals as to classification and other similar matters. This permits the remedy of errors, and injustices of all kinds in the administration of the tariff laws and regulations; and this makes the United States tariff administration very efficient and just to all. The collector receives the duties and pays them over to the Treasury Department. (See TARIFF ADMINISTRATION). Consult Bolles, A. S., 'Financial History of the United States' (1886); Dewey, D. R., 'Financial History of the United States' (1903); Goss, J. D., 'History of Tariff Administration in the United States' (1891).

TARIFF LAWS, the various enactments of Congress, extending from 1789 to 1913, to regulate import duties. Those of recent date are: The Morrill Tariff Act (1861); McKinley Tariff Act (1890); Wilson-Gorman Tariff (1894); Dingley Tariff Act (1897); Payne-Aldrich Tariff Act (1909); Underwood Tariff Act (1913). See TARIFF ADMINISTRATION IN THE UNITED STATES.

TARIJA, tä-rē'hä, Bolivia, the capital of the department of the same name, situated among the mountains near the Argentine frontier and having an area of 31,567 square miles. It lies on a fertile mountain plain and has a pleasant climate. The town has a handsome church, and there is considerable transit trade with Argentina. Pop. of town, about 10,000; department, about 165,000.

TARIM, tä-rēm', central Asia, a river of East Turkestan, formed by the confluence of the Aksu, Yarkand and Khotan-Darya at the southern base of the western Tyan-Shan ranges, 60 miles southeast of Aksu. Thence it flows east and finally southeast, losing itself in the group of lakes and salt marshes known as Lob-nor, at the northern base of the Kuen-Lun range. With its main headstream, the Yarkand, the Tarim River encircles the vast desert plain of Turkestan, receiving nearly all its tributaries from the surrounding mountains on its left bank. The Tarim and its basin were first thoroughly explored and mapped by Hedin, during the last years of the 19th century.

TARKINGTON, (Newton) Booth, American novelist: b. Indiana, 29 July 1869. He was graduated from Princeton in 1893 and his first novel, 'The Gentleman from Indiana' (1899), attracted widespread and favorable attention. Thenceforth he followed literature, with the exception of serving one term in the Indiana legislature in 1903. His next works were 'Monsieur Beaucaire' (1900); 'The Two Vanrevels' (1902); 'Cherry' (1903); 'The Beautiful Lady' (1905); 'The Conquest of Canaan' (1905); 'Gust of Quesmay' (1908); 'Beauty and the Jacobin' (1911); 'The Flirt' (1913); 'Penrod' (1914); 'Seventeen' (1916); 'Turmoil' (1917); 'Robert Cortes Holliday' (1918); 'The Magnificent Ambersons' (1918). He has also written several plays, the most successful being 'Monsieur Beaucaire' (after the novel), in which he collaborated with Harry L. Wilson.

TARKIO (tär'kẹ-ō) **COLLEGE,** located at Tarkio, Mo. It was established by private initiative in 1883 under the name of Tarkio Valley College and Normal Institute. A new charter was obtained in 1884 by which the name was changed to Tarkio College and the institution came under the control of the United Presbyterian Church. The college has been from the first coeducational. Its organization includes a collegiate department, a normal department, a preparatory department, a musical department and a commercial department. The collegiate department offers two courses leading to a degree, the classical (degree of A.B.), and the scientific (B.S.), and a third course, the literary, for the completion of which a diploma is granted; this latter omits one year of the work of the scientific course. The normal course occupies four years; students are allowed to pursue the studies they most need. Students in both this and the commercial department can take additional studies in any of the collegiate courses. Bible study is a part of the curriculum in the preparatory and collegiate courses. The college has a campus of 20 acres a little above the town; the chief buildings are the main building, Marshall Hall (women's dormitory) and Gentlemen's Hall. In 1901 David Rankin gave $53,000 toward the increase of the permanent endowment, and the productive funds were in 1917 $163,000. The library in 1917 contained 8,300 volumes; the students numbered 235 and the faculty 23.

TARLAC, tär'läk, Philippines, (1) Pueblo, capital of the province of Tarlac, Luzon, on the Bolso River at the point where its name changes to Tarlac, and on the Manila and Dagupan Railroad, 73 miles northwest of Manila. In addition to the railroad it has excellent highway facilities, and is the centre of trade for the surrounding country. Pop. 12,340. (2) An interior province in the southwestern part of northern Luzon, bounded on the north by Pangasinán, on the east by Nueva Ecija, on the south by Pampanga and on the west by Zambales; area, 1,295 square miles. In shape it is approximately square, measuring 37 miles from north to south and 39 miles from east to west; the eastern part is level, while the western part includes the eastern slopes of the Cordillera de Cabusetan, the highest peak being Mount Iba, 1,604 feet. The province is watered by numerous rivers. Rice is the most important product; sugar is also raised in large quantities, and tobacco and corn on the higher levels. The forests are valuable, and the timber is easily obtained on account of the numerous rivers, and their proximity to the forest lands. There are a few mechanical industries for domestic use only. The province is traversed by the Manila and Dagupan Railroad, the main highways and numerous lesser roads; the rivers also are navigable for native boats, so that the facilities for trade are excellent. Pop. about 135,000.

TARLATAN, a thin and fine species of open, transparent muslin, mostly used for women's wear, originally esteemed as high grade, but later deteriorated. The chief seat of the manufacture is Tarare, in France.

TARLETON, Sir **Banastre,** English soldier in the Revolution: b. Liverpool, 1754; d. Leintwardine, Shropshire, 25 Jan. 1833. In 1775 he entered the English army as cornet in the king's dragoon guards, and obtained leave to accompany Lord Cornwallis to North America, as volunteer. He was present with Clinton's army at the attack on Charleston and other operations, then served with Sir William Erskine's cavalry, attacking and capturing New York (September 1776), Fort Washington and Fort Lee in November. He commanded the advance guard under Harcourt and captured General Lee (13 December) and was present in operations around Brunswick, Princeton and Trenton (1777). In 1780 he fought around Charleston capturing (by surprise) three regiments of American cavalry with their stores, just before the capitulation of Charleston. He aided in the capture of Camden. In the South he had to retreat, after Morgan's victory at Cowpens, to Hamilton Ford. Joining Leslie in January 1780 they returned and successfully attacked Morgan. But in spite of Tarleton's numerous successes the attacks of Lafayette and Wayne rendered the Cornwallis position hopeless and, with the surrender to Washington, Tarleton returned to England (1782) on parole. He was made lieutenant-colonel of light dragoons in December, then entered Parliament (1790) representing Liverpool, retaining his seat till 1807. In 1807 he was again elected to sit till 1812, giving his seat to Canning. He was promoted (1790) to colonel, then to major-general (1794) and lieutenant-general (1801). After several short commissions to Ireland and elsewhere he was made (1808) governor of Berwick and Holy Island. In 1812 he was promoted to general and was created baronet in 1815. He was certainly a clever, daring and successful leader of cavalry, but history would give him the blame for unnecessary cruelty, resorting at times to butchery. He wrote 'History of the Campaigns of 1780 and 1781 in the Southern Provinces of North America' (London 1787).

TARN, tärn (ancient Tarnis), a river of France, which rises on the south slope of Mount Lozère, near Florac, in the department of Lozère. It flows west-southwest, crosses the departments of Averyron and Tarn, passing Alby, turns northwest through Haute-Garonne into Tarn-et-Garonne, where it passes Montauban, turning almost due west, passes Moissac, and joins the Garonne on the right a few miles below. Its whole course is 230 miles, of which about 100 miles, beginning at Alby, are navigable.

TARNOPOL, tär'nō-pōl, Austria, town in Galicia, on the left bank of the Sereth, 80 miles east-southeast of Lemberg, near the Russian border. It has a Roman Catholic and a Greek Catholic church, an old castle, now used as barracks, a new castle, a Jesuit college, a gymnasium, a Polish real-school and several other schools. A thriving trade in refining and brewing, horses, grain, wax, honey, etc., is carried on. Pop. about 35,200.

TARO, a plant (*Colocasia antiquorum esculenta* and related forms) of the arum family, widely grown for food in tropical regions, especially in the islands of the Pacific. The plant has very large heart-shaped leaves, from thick tuberous roots, and small greenish flowers, resembling those of the calla, to which it is related. A form, still grown in Egypt and used as food by the laboring classes, is known to be of great antiquity. In the Pacific region hundreds of forms of taro are recognized by the natives. Taro is used in Hawaii chiefly in the form of poi, a paste made by boiling and grinding the roots and allowing them to ferment for a day of two. The roots are used in many other ways, like the potato. The leaves, also, when cooked to destroy their acridity, are used for food.

TARPAN, a local name for the Asiatic wild ass.

TARPAULIN, originally a broad piece of canvas, thoroughly coated with tar, and used to cover the hatchways of a ship at sea, to prevent the penetration of the rain or seawater which may at times rush over the decks; now any heavy waterproof canvas for protecting goods from water.

TARPEIAN (tär-pē'yan) **ROCK,** Italy, a portion of the Capitol at Rome, so named from the tradition that during a war with the Sabines, Tarpeia, the daughter of the governor of the citadel of Rome, promised to open the gates of the city to the Sabines, provided they gave her what they carried on their left hands, meaning their gold bracelets. The Sabines consented, and as they entered the gates threw not their bracelets but their shields upon Tarpeia, who was crushed to death under the weight. She was buried in the Capitol, which from her was called the Tarpeian Rock; and there Roman malefactors were afterward thrown down a deep precipice. See ROME.

TARPON, or **SILVER KING,** a great and powerful fish (*Tarpon atlanticus*, or *Megalops thrissoides*), known from Virginia to Brazil, and regarded by anglers as the finest of American game fishes. It is related to the herrings and resembles them in general outline, but is sometimes six feet long. Its special marks are the long filamentous appendage of the posterior margin of the dorsal fin and the huge, round, shining scales, which encase the body in an armor of glittering silver, and make the name «silver king» peculiarly appropriate for this noble fish. Among the French and Spanish fishermen about the Gulf of Mexico and West Indies it is called *grande ecaillé*, *sabalo*, *savalle*, etc.; while tarpium, jewfish and big-eyed herring are also heard. Its scales, as large as or larger than a silver dollar, are extensively used in fabricating ornaments, and the flesh is good to eat; but the fish is principally of interest for the sport it affords to the angler with rod and line, who seeks it best by going in a boat, with an experienced man at the oars, among the islands or into the bays of the coast of the Gulf of Mexico, within the Florida reefs or around the shores of Porto Rico, where it spawns. Then may be felt as well as seen the astonishing force and strength which this fish daily puts forth as he chases the swift and agile fishes upon which he subsists. Having seized the angler's baited hook, a struggle begins which taxes tackle and skill to the utmost. The moment the tarpon feels the steel point in his mouth and finds his progress checked, he leaps high into the air, shaking himself violently in hope of casting off the hook — and he often succeeds. Failing, he leaps again and again; «with all the frenzy of the wild horse when he first feels the lasso, he springs through the air and dashes through the water.» An hour or more of the most delicate manipulation, and at the same time of severe labor, is often required to subdue a large tarpon.

TARQUINIUS, tär-kwĭn'ĭ-ŭs, **Lucius** (surnamed PRISCUS), in legendary history the fifth king of Rome. His family was of Greek extraction, his father, Demaratus, being a Corinthian, who crossed to Italy and settled in Tarquinii, a city of Etruria. He introduced among the Etruscans the knowledge of the alphabet. He had married Tanaquil, a Tuscan lady of rank, by whom he had two sons, but on account of foreign extraction he was excluded from public employment. He accordingly removed to Rome, where he was welcomed and admitted to Roman citizenship. He took the name of Lucius Tarquinius. The surname Priscus, the elder, may be considered as a historical distinction. Tarquinius became the confidant of the king of Rome, Ancus Martius, who appointed him the guardian of his children. On the death of Ancus, Tarquinius was elected his successor. He made war on the Latins and Sabines, from whom he took numerous towns, and his reign was distinguished by the erection of great public works. The Roman Cloacæ (q.v.) are the greatest of the works attributed to him. He constructed the Circus Maximus in the valley redeemed by his system of drainage, and instituted the great Roman games. He began the wall around the city. He is also said to have projected or begun the Capitol in honor of Jupiter, Juno and Minerva. For the political changes which he instituted see ROME. After a reign of 36 years, or 38 according to the legends, he was killed by assassins employed by the sons of Ancus Martius in 578 B.C.

TARQUINIUS, Lucius (surnamed SUPERBUS), last of the legendary kings of Rome, was the son of Lucius Tarquinius Priscus. Tarquinius Priscus left two sons, who were too young to succeed him, and his son-in-law, Servius Tullius, excited the patricians against him by extensive constitutional reforms, and Tarquin, on reaching man's estate, murdered his son-in-law and assumed the regal dignity as a hereditary right. As a king he developed all the distinguishing traits of a tyrant. He abolished the privileges conferred by his predecessor on the plebeians; but did not favor the patricians. He banished or put to death the senators whom he suspected. He continued the great works of his father, and compelled the populace to labor in them for inadequate pay. While he thus established his tyranny at home he advanced the power of Rome abroad. By the marriage of his daughter with Octavius Mamilius of Tusculum, he caused himself to be recognized as the head of the Latin confederacy. Through a stratagem of his son Sextus he obtained possession of Gabii, a Latin city, which resisted him. He made war on the Volscians, and took the city of Suessa Pomœtia, the spoils of which he used to build and decorate the Capitol. He formed also a close alliance with the Etrurian cities. To keep down the Volscians, he founded the colonies of Signia and Circeii. It was he who deposited the Sibylline books in the vault of the Capitol. After a reign of nearly 25 years he was engaged in besieging Ardea when the conspiracy broke out by which he was exiled from Rome 510 B.C. The cause and nature of the conspiracy are referred to in the articles BRUTUS (LUCIUS JUNIUS) and LUCRETIA. Tarquin first took refuge at Cære and Etruria. The Etruscan cities of Tarquinii and Veii first espoused his cause, then Lars Porsenna of Clusium, and afterward the Latin states. When all these had been vanquished, according to Roman accounts, Tarquinius, whose sons had perished in the wars, fled to Cumæ, where he died. The chronology of the story of the Tarquins is incompatible with strict historical accuracy, and neither criticism nor comparison of accounts has enabled historians to disentangle the truth from fiction. Some, as Niebuhr and K. O. Müller, hold that the history of the Tarquins points to an Etruscan conquest of Rome. Others accept the main incidents as historical.

TARR, Ralph Stockman, American geologist: b. Gloucester, Mass., 15 Jan. 1864; d. 1912. He was graduated from Harvard in 1891, and was assistant in geology there 1890–91. From 1892–97 he was assistant in geology at Cornell University, and thereafter professor of dynamic geology there until his demise. He has published 'Economic Geology of the United States' (1893); 'Elementary Physical Geography' (1895); 'Elementary Geology' (1897); 'Physical Geography of New York' (1902); 'Geography of Science' (1905); 'Alaskan Glacier Studies' (1914); 'College Physiography' (1914).

TARRAGON, a culinary herb. See ARTEMISIA.

TARRAGONA, tär-rā-gō'nä, Spain, a seaport town on the Mediterranean, capitol of a province of the same name, in Catalonia, 60 miles west-southwest of Barcelona, at the eastern end of the fertile Campo de Tarragona, which is watered by the river Francoli. The old town, situated on a high rocky site, once surmounted by a citadel, has narrow, irregular streets. The chief features are the splendid cathedral, dating from the 12th to 13th century, with a fine west façade and cloisters of great beauty, the archiepiscopal palace, with an ancient tower, and a seminary for priests. The Plaza de la Fuente, on the site of the Roman Circus, separates the old town from the more regular new town to the southwest, which, near where it joins the old town, is crossed by two broad tree-shaded streets. The Paseo de Santa Clara is a fine promenade on the remains of the old Roman walls. The other edifices include the presido or prison, the Torreón de Pilatos, also a prison, the Casa Provincial de Beneficencia, artillery arsenal, infantry barracks, etc. The town and its neighborhood are rich in Roman remains. The spacious harbor is sheltered by a long mole, and has been recently improved. Tarragona was known to the Romans as *Tarraco.* It was captured by the Romans 218 B.C. during the Second Punic War, and made their headquarters in Spain. It is also associated with Julius Cæsar and Augustus, the latter of whom made it the capital of the province of *Hispania Tarraconensis.* It was taken by the Visigoths in 475 A.D., and by the Moors in 713. On 29 June 1811 it was captured and plundered by the French under Suchet. Its archbishop shares with the archbishop of Toledo the title of primate of Spain. Pop., town, 24,548; province, 336,763.

TARRYTOWN (from the Dutch, *Terwen Dorp,* «Wheat Town»), N. Y., village, Westchester County, on the Hudson River, or the expansion of the river called Tappan Sea, and on the New York Central and Hudson River Railroad, about 25 miles north of New York and 130 miles south of Albany. A ferry, which connects the village with Nyack on the west bank of the Hudson, gives Tarrytown the advantages of the West Shore Railroad.

Tarrytown is one of the oldest settlements in New York; its position on the Hudson made it a convenient landing place for boats going from New York to Albany, and gradually it became a trading post. Its first incorporation included Irvington (q.v.). During the Revolutionary War Tarrytown was a centre of importance; every prominent hill in the vicinity was the scene of an encounter or a fortification. In Tarrytown André was captured. On Broadway, one of the prominent streets, about half way to Sleepy Hollow (q.v.) stands a monument commemorating this event so important in the War for Independence. The first monument erected was a small obelisk, raised in 1853 by the inhabitants of the county, and bearing upon its pedestal an inscription which told that it marked the «spot» where, on 25 Sept. 1780, the spy, Maj. John André, was captured by «John Paulding, David Williams, and Isaac Van Wert, All Natives of this County.» In 1880, the centennial anniversary of this capture, there was added a bronze statue of John Paulding; and a bronze panel, upon which was pictured, by Theodore Bauer, the capture of André. The additions of 1880 were the gift of John Anderson. The little stream nearby is called André Brook, and a large whitewood, which formerly stood near the monument, was called André's tree. In 1777 Vaughan's troops landed here; and here, at the tavern kept by Elizabeth Van Tassel, occurred the capture of the British by Major Hunt and a force of volunteers. The village is well known on account of being the birthplace and home of Washington Irving (q.v.). On the north is Sleepy Hollow (q.v.), where he was buried, on the south of the village is Sunnyside (q.v.), where his home still stands. Other points of historic interest are «Lyndehurst,» formerly «Paulding Manor,» the Philipse manor house, erected in 1683; a monument to the Revolutionary soldiers of the manor, unveiled in 1894; and the summer residences of many of the noted men of New York.

Tarrytown is in an agricultural region, but it has about 100 manufacturing establishments with a large annual output. The principal public buildings are the Institution of Mercy, an orphanage for boys; the churches, schools and business blocks. The educational institutions are the Washington Irving High School, Irving Institute, Miss C. E. Mason's School, The Knox School, Hackley School, Mary Mount School, public and parish schools, three public libraries and several private schools. The national bank has a capital of $100,000, the savings bank has deposits amounting to about $2,000,000. Pop. about 5,752; including North Tarrytown, 4,877, which is industrially a part of the village; total, 10,629.

TARSHISH, a place frequently mentioned in the Old Testament. It was formerly believed to be Tarsus in Cicilia, but is now generally identified by Biblical critics with the Tartessus of the Greek and Roman writers. This name was applied to a district in the south of Spain, lying to the west of the Columns of Hercules. Others regard it as some unidentified European coast west of Greece.

TARSIA (Ital. *Intarsia*). Wood inlay; especially that done in Italy at the close of the Middle Ages and during the era of the Renaissance. The word is received into English as being the only one describing inlay of that era and character as distinguished from that of others. Thus nearly all Tarsia work is done with dark wood like walnut, on which straight lines and curves are incised rather deeply and the incisions then filled with light colored wood, producing, when the work is complete, a general effect of yellow on brown. These lines and curves make scrolls of different patterns which terminate in small flowers and clumps of foliage, and in this way help to carry out the great scheme of arabesque decoration which we associate with Renaissance proper in all the schools of Italy. Heavy furniture, such as cupboards and cabinets, ornamental chests for the storing of clothing, and the like, are adorned in this way; but the most effective examples of the art are in the wooden fittings of church choirs and the long rows of cupboards and closets (ambries) which line some of the sacristies of the churches in central and northern Italy.

Wood inlay of later times and of the North is not often called Tarsia, but the process is the same, and the effects produced differ only according to the style of the time. The most interesting wood inlay out of Italy is that of the Dutch — chests of drawers, wardrobe and writing tables in which spirited little bouquets and flowers are relieved on a dark ground. This, and all northern inlaid work, disappear in the 17th century in what we call Marquetry (q.v.), which is a mosaic of veneers rather than an inlay. Consult Jackson, F. Hamilton, 'Intarsia and Marquetry' (1903).

TARSIER, a small lemur of the genus *Tarsius,* having extremely long hind legs, especially in the thin tarsal portion, large, slender toes and enormous eyes. These grotesque little creatures inhabit tropical Africa and the Eastern Archipelago. They are for the most part of nocturnal habits and feed on fruits and insects found in the tree-tops where they spend their lives. The tarsier (*T. spectrum*) is a representative species of this genus, occurring in Borneo, Celebes, the Philippine Islands, etc. It is grayish-brown, with olive tints over the body, and dark tints on the face, forehead and back of the head. The tail is destitute of hairs, but possesses a tuft at its tip.

TARSUS, Asia Minor, an ancient city, the capital of Cilicia, now in the Turkish province of Adana, connected by rail with Adana and the port of Mersina on the Mediterranean. Anciently it was adorned by a number of magnificent buildings. Its inhabitants enjoyed the privileges of Roman citizens, and the city rose to such distinction as to rival Athens, Antioch and Alexandria in wealth and grandeur, as well as in the arts and sciences. It is the birthplace of Saint Paul. It was situated on both banks of the Cydnus, which flowed into a lagoon connected with the sea, which formed its port, but is now silted up. Its origin is ascribed to Sardanapalus. It was early colonized by the Greeks. It is mentioned in the 'Anabasis' of Xenophon as a great and wealthy city. Tarsus was visited by Cyrus in his expedition against his brother Artaxerxes, and partially plundered by his troops. It yielded without resistance to Alexander the Great. Tarsus belonged in general to the empire of the Seleucidæ, but was for a short time connected with Egypt under the second and third Ptolemy. Pompey made Cilicia a Roman province. Out of compliment to Cæsar, who visited the city, the inhabitants changed its name to Juliopolis. It was plundered by Cassius, but Antony and Augustus heaped favors on it. It became a place of importance in the wars of the Romans with the Parthians and the Persians. It was taken by the Saracens in 640, after which its importance declined. The most important remains of the ancient city is the Dunuk Tash or "Tomb of Sardanapalus," presumably part of a Græco-Roman temple. The heterogeneous population of Mohammedans, Armenians, Greeks, Persians, etc., in the modern town is estimated at 25,000.

TARSUS (in anatomy). See ANATOMY; FOOT; OSTEOLOGY.

TARTAGLIA, tär-tal'yä, **Nicola,** Italian mathematician: b. Brescia, about 1500; d. Venice, 13 Dec. 1557. His family name was Fontana and he was given the name of "Tartaglia," the "stutterer," from a defect of utterance contracted during his neglected childhood. From the year 1530 he taught mathematics at Verona and Vicenza, was appointed professor of mathematics at Brescia and in 1534 was called to the same post in Venice. He discovered the method of solving the cubic equation containing the 1st and 3d powers of the unknown quantity, and in repeated contests with the ablest mathematicians of his time defeated them, being able to solve all their problems, while his own remained unsolved. In 1539 and 1540 Cardan, under the promise of strict secrecy, obtained from him his discovery, and afterward, in violation of his promise, published it in his 'Ars Magna.' This led to a violent controversy and a public mathematical contest, in which Cardan being worsted, his townsmen raised a mob and prevented a continuance of it. But the solution is still known as Cardan's rule. His chief work is 'Generale Trattato de' Numeri e Misure' (1560). He also published a treatise on gunnery, 'Nuova Scienza,' which has been translated into English by Lucar; the first Italian translation of Euclid; and seven or eight other mathematical works, the best known of which is 'Quesiti ed invenzioni diversi' (1550).

TARTAN, the typical Scottish plaid; a thin worsted cloth having alternate bands of different colors, forming a checkered pattern, which has been highly specialized by Scotch weavers for the dress of the Scottish Highlanders, each clan having its own peculiar pattern. The well-known Stewart tartan is scarlet in the centres, with dark scarlet crossings and wide-spaced dark independent lines. An endless variety of fancy tartans are now manufactured, some of wool, others of silk or of mixed material. The term is also applied to the checkered patterns themselves.

TARTAR. See ARGOL.

TARTARAGA, a South American turtle of the family *Pelomedusidæ;* specifically the great "arrau" or river-turtle (*Podocnemis expansa*) of the Amazon Basin, the female of which has a shell sometimes measuring three feet in length. This turtle is of great commercial importance throughout northern South America, on account of the eggs, which are periodically collected from the sand banks where they are buried in great quantities, chiefly for the oil to be pressed from them. This is either eaten, like the eggs themselves, or is burned in lamps alone or mixed with tar. The turtles are likewise eaten by man and many animals.

TARTARIC ACID, Dihydroxysuccinic Acid, $\begin{array}{l}CHOHCOOH\\ |\\ CHOHCOOH\end{array}$ exists in four stereoisomeric modifications; these are known as (1) Dextrotartaric acid, or Ordinary tartaric acid, (2) Lævotartaric acid, (3) Racemic acid and (4) Mesotartaric acid.

1. **Dextrotartaric Acid** and some of its salts are widely distributed in the vegetable kingdom, its acid potassium salt being present in large quantities in grape juice. When grape juice is fermented, the acid salt, being only sparingly soluble in the alcohol produced, forms a dirty-white crust or sediment in the fermentation casks; this deposit is known as «argol» or «lees.» Cream of tartar and ordinary tartaric acid are usually obtained from this source. For the preparation of cream of tartar, argol is simply freed from impurities by treatment with animal charcoal and by subsequent crystallization. For the manufacture of ordinary tartaric acid, argol is boiled with dilute hydrochloric acid and then precipitated as calcium tartrate with calcium hydroxide. The yield is increased by adding calcium chloride to the mother-liquor. From the calcium salt thus precipitated tartaric acid is liberated with dilute sulphuric acid.

A number of synthetic methods are also in common use for the manufacture of tartaric acid. According to British Patent 12,467, the compound may be obtained by the electrolytic reduction of glyoxylic acid or its derivatives; the glyoxylic acid used in this process being formed from oxalic acid by the action of amalgams. The method of L. Baekeland (United States Patent 1,190,845) consists in building up the acid from the oxides of carbon by converting them into formates; from these, oxalates are obtained at high temperatures and pressures; the oxalates are reduced to glyoxylates, and the latter electrolyzed into tartrates. Tartaric acid has also been obtained by the oxidation of carbohydrates in the presence of catalyzers (British 108,494).

Dextrotartaric acid crystallizes in transparent prisms, free from water of crystallization. It melts at 170° C.; above this temperature it yields pyrotartaric acid, acetone, acetaldehyde and other decomposition products. It is very soluble in water and alcohol, but is insoluble in ether. In aqueous solution it turns the plane of polarization to the right, reduces ammoniacal silver compounds, is readily decomposed into glyoxal and other products in the presence of uranium salts, and yields large quantities of carbonic acid and acetaldehyde in the presence of manganese dioxide at or above 35° C. Under the influence of ultra-violet rays tartaric acid evolves carbon dioxide. The crystals of the acid show triboluminescence. In the form of its acid potassium salt the compound has been used by the ancients. The pure acid was first described by Scheele in 1769.

2. **Lævotartaric Acid** differs from the dextro compound in that its aqueous solutions turn the plane of polarization to the left. It was first prepared by Pasteur from sodium ammonium racemate. When this salt is allowed to crystallize it deposits two sets of crystals from which dextro- and lævo-tartaric acids may be obtained. Pasteur's observations showed incidentally that the molecule of racemic acid is a complex of dextro- and lævo-tartaric acids. Pasteur also found that when the cinchonine salt of racemic acid is allowed to crystallize, the first crystals consist of the cinchonine derivative of lævotartaric acid. The physical and chemical properties of this compound are practically those of dextrotartaric acid.

3. **Racemic Acid** occurs with ordinary tartaric acid in the grapes of certain districts. It may be prepared (1) by mixing strong equimolecular solutions of dextro- and lævo-tartaric acids, (2) by the saponification of glyoxal cyanhydrin, (3) by heating dextrotartaric acid for a number of hours with caustic alkalis, and by other methods. It separates in triclinic crystals with one molecule of water. It melts at 205–206° C. It is only moderately soluble in cold water or alcohol. Solutions of racemic acid do not show optical activity, the compound being inactive by external compensation.

4. **Mesotartaric Acid** is formed together with racemic acid when a solution of ordinary tartaric acid is heated with caustic alkalis. It has also been prepared synthetically by heating dibromsuccinic acid with water or silver oxide. It crystallizes in long prisms with one molecule of water. The dehydrated acid melts at 140° C. It is optically inactive by internal compensation.

Of the four tartaric acids described in this article, ordinary or dextrotartaric acid is a most important compound. It is extensively employed in dyeing, bleaching, calico-printing, in the preparation of effervescent drinks, in the manufacture of baking powders, seidlitz powders, in photography, and in medicine. Sodium potassium tartrate, or Rochelle salt, forms Fehling's solution with copper sulphate and is used in urine analysis; potassium acid tartrate, or cream of tartar, is a mild cathartic; potassium antimonyl tartrate, or tartar emetic, is occasionally used as a counter-irritant in the form of an ointment, and finds extensive application as a mordant; potassium magnesium tartrate is used as a purgative; iron and potassium tartrate as a mild chalybeate; morphine tartrate has been recommended for hypodermic injection; dimethyl piperazine tartrate as a solvent for uric acid in chronic and acute gout; and paraphenetidin acid tartrate as an antipyretic.

V. S. Babasinian,
Lehigh University.

TARTARIN. 'Tartarin de Tarascon' (1872), 'Tartarin sur les Alpes' (1886) and 'Port-Tarascon' (1890) present Daudet's best remembered characterization, a typical Frenchman of the Midi, such as he has himself described in speaking of his other notable son of the South, Numa Roumestan: «pompous, theatrical, loving parade, costume, the platform, banners, flags, trumpets, clannish, traditional, caressing, feline, with an eloquence brilliant, excited yet colorless, quick to anger and yet giving anger a sham expression even when it is sincere.» Looking back on his creation after many years, Daudet wrote: «It seems to me that 'Tartarin' has qualities of youth, vitality, truth,— a truth from over the Loire, that may swell and exaggerate facts, but never really lies.»

This presentation of «truth from its humorous side,» in the phrase of Daudet's fellow Provençal, Zola, developed out of observation of a traveling companion on a journey to Algeria, Corsica and Sardinia, in 1865. The writing was begun in 1868, but this «cinematograph of the Midi» first showed its subtle caricature of Gascon temperament in 1872. The time, just after the disastrous war with Germany, was unpropitious, and the serial publication in the *Petit Moniteur* met so cold a welcome that it was abandoned. The hero's name was then Chapatin. With its change to Tartarin, but with none in the temper and spirit of the work, the playful satire, under other auspices, was sustained through three volumes and 18 years; and, though the jest was carried further than any other French author has cared to venture in like case, Frenchmen are generally agreed in recognizing in the three volumes together a classic of «admirable fooling.»

'Tartarin,' says Daudet, had two quite distinct characters, the soul of Don Quixote, the body of Sancho Panza. He planned for travels and adventures so vividly that he half believed he had experienced them, his favorite reading supplying the local color for the self-deception that made «of a man who had missed going to Shanghai one who had been there.» «The Southerner's falsehood,» explains Daudet, «is not a lie but a kind of mental mirage.» This Tartarin, who dreamed of daring deeds in exotic lands, till he was 45 had never slept out of his home town. The Quixote in him was always exclaiming: «I go»; the Sancho: «I stay.» «Tartarin cover yourself with glory,» said Quixote. «Cover yourself with flannel, Tartarin,» said Sancho. «Give me a tomahawk,» cries Quixote. «Jeanette, my chocolate,» says Sancho. A lion seen at a circus fires his fancy. At last he feels he must go to Africa to maintain his self-esteem and reputation at home. Elaborate preparations keep his fantasy at fever heat till he sets out for Algeria. Illusion and disillusion follow, in amusing succession, his landing in exotic equipment among the very Europeanized denizens of Algiers. Mistaking a plantation of artichokes for a desert, he shoots a donkey for a lion, where rabbits are the customary game, beguiles himself and is beguiled with Oriental pleasures, is recalled to his Quixotic self by a paragraph in a home journal, turns his face resolutely southward, encounters a tame and blind lion, imagines he has fired at another, is robbed by his companion, an alleged prince, shoots the tame lion and returns with a melancholy camel, whom he sought to abandon in Algiers but who refused to stay lost, much poorer in purse but having earned the privilege of dazzling his fellow-townsmen with tales that he, confirmed by the skin of the tame lion, himself half believes to be true.

So ends this delightful bit of Provençal persiflage. Often, as obvious, it grazes the burlesque, but is always saved with unfailing tact from mere buffoonery. In 'Tartarin on the Alps' the spirit and method are the same, the satiric art a little mellower and more mature. It is also more readily appreciated, as the scene is more generally familiar. The public and the critics join in pronouncing it the masterpiece of French humor in the 19th century. The opening scene where Tartarin, equipped as for the Himalayas with ice-axe, climbing irons, snow-glasses and the rest, makes his entry into the palatial hotel on the Rigi, with its 600 very prosaic tourists, is unforgetable; so, too, is the tale of Tartarin's hunt of the tame chamois, trained to attract strangers and fed in the hotel kitchen. The Swiss Exploitation Trust, creation of the exuberant fancy of Tartarin's fellow Tarasconian Bompard, is itself most genially exploited; and nothing in any of the Tartarin books surpasses the scene of mild mountain climbing where each of these comrades supposes he has sacrificed the life of the other to his own safety by cutting the cord that bound them, while both are safe and sound. In the afterpiece to this episode Tartarin enters the Tarascon Alpine Club as Bompard is narrating how the partner of his daring perished.

Port-Tarascon, many of whose extravagances were suggested and rivalled by the facts of an actual colonizing enterprise some years before at Port-Breton, depends for its full appreciation on fuller knowledge of French political conditions and aspirations than most foreigners possess. Daudet himself probably felt that the once rich vein had been worked a little thin, for here he brings Tartarin to a not unworthy death, after carrying him through strange adventures as head of colonist fellow-townsmen in Polynesia and then, after his enforced return, through a trial whose hilarious humor involves a masterly discrimination between the calculating falsehood of the Nord and the effervescent imagination of the «fecund improvisators» of the Midi, «intoxicated with sap and light, carried away by their own inventions.» For translations of 'Tartarin de Tarascon' and 'Tartarin sur les Alpes' consult 'Everyman's Library.' 'Port Tarascon' has been well rendered by Henry James.

BENJAMIN W. WELLS,
Author of 'Modern French Literature.'

TARTARS. See TATARS.

TARTARUS, tär'ta-rŭs, according to classical antiquity, a deep pit which extends under the surface of the earth as completely as heaven extends over it, holding within closed portals Kronos and the Titans in their prison house. It was the jail established by the mythical gods for those whom they had driven from the supernal world, just as Erebus was a similar prison for men. Later the term came to signify the whole underworld in which the wicked undergo the punishment of their crimes, the exact opposite to the Elysian fields, the afterworld of the good. Tartarus, as a personification, is the son of Æther and Ge (air and land), and father of the giant Typhœus by his own mother, Ge.

TARTARY, tär'ta-rĭ, or **TA'TARY**, a name applied in the Middle Ages to the countries from which the Tartars came or in which they lived, that is, central Asia and what is now southeastern Russia, western and eastern Turkestan, Mongolia and Manchuria. In a narrower sense it includes only southeast Russia and Chinese Turkestan.

TARTE, tärt, **Joseph Israel**, Canadian stateman: b. Lanoraie, Quebec, 11 Jan. 1848; d. 1909. He was educated at L'Assomption College, was a member of the Quebec assembly in 1877-81 and was returned to the Canadian Parliament for Montmorency in 1890. He was unseated by petition in 1891, as a result of his insistive attacks in the administration of Macdonald, whose ministers he charged with corruption, but in 1893-96 was member for L'Islet. He was later, under the Laurier administration, Minister of Public Works, and has also edited, at Montreal, *Le Cultivateur*, and *La Patrie*.

TARTUFFE, a comedy of Molière in five acts in rhymed verse, the first three acts of which were presented for the first time before the king and queen at Versailles, 12 May 1664, when the author was 38 years old. The play made enemies everywhere. There were those among the Jansenists and Jesuits who each thought that the others were aimed at, and a violent attack was written by the curate Pierre Roullé under the title «Le Roy glorieux au monde» (Paris 1664), which upon Molière's protest was censured by the king. The latter nevertheless forbade the play to be presented again until finished. On 5 Aug. 1667, a second version of the play was presented at the Palais-Royal under the title «L'Imposteur.» Molière, apparently upon the suggestion of the papal legate and his entourage, had softened it in several respects; for instance, the original Tartuffe was no longer in ecclesiastical garb. Nevertheless its presentation was stopped, in the king's absence, by the first president of Parliament and interdicted by the archbishop of Paris. The king, despite his prohibition, had shown his favor by taking Molière's players under his patronage in 1665. It was only on 5 Feb. 1669, however, that a third version, the only one known to us now, was acted at the Palais-Royal by the king's permission under the original title, and the poet's long years of waiting for a hearing were rewarded by extraordinary success. The plot of the play, which is masterly in its simplicity and logic, concerns the entrance of one Tartuffe (or Tartufe or Tartufle), a self-seeking adventurer hiding his greed behind the mask of piety, into the house of Orgon, a well-to-do burgher, whose docile daughter, Mariane, has been affianced to Valère. Orgon (played by Molière) and his opinionated old mother, Madame Pernelle, fall completely under the sway of Tartuffe over the protest of the rest of the family, including a rather hot-headed son, Damis, and a sensible and even-tempered brother-in-law, Cléante. Orgon goes even so far as to make a deed of gift to Tartuffe and to promise his daughter to him, despite a previous promise to Valère. It was not on the daughter, however, but on Orgon's second wife, Elmire, young and comely, that Tartuffe had cast longing eyes. To save her step-children, Elmire (played by Molière's wife) consents to lure Tartuffe into an avowal which her husband in hiding may overhear. This scheme being successful, the impostor throws off the mask and impudently claims the house under the deed of gift. Orgon's ruin is narrowly averted by the intervention of Louis XIV, a veritable *deus ex machina*, whose messenger restores the house to Orgon and hales the villain off to prison. It is not only for the singularity and boldness of the subject or the skill in with which it is treated that this play merits approval. The first scene is as happy as it is new, as full of simplicity as of life. Instead of those mutual confidences which are so commonly made use of in this place, an old grandmother, offended at what she has seen amiss in her granddaughter, is introduced giving a severe lecture to those who belong to the house, in which she draws the characters of them all; for we distinguish the truth even through the language of prejudice. From this moment everything is in motion and the action gradually increases to the end. The fine raillery of Dorine (played by Madeleine Béjart), a maid, in the scene with her master, gives us a clear idea of Orgon and prepares us for Tartuffe in the picture of hypocrite, which Cléante opposes to that of the truly devout. Tartuffe, who is only talked of in the first two acts, makes his appearance in the third, when the plot being then more animated receives equal vivacity from the new schemes employed against this villain and from the address with which he turns everything attempted against him to his own advantage. The infatuation of Orgon, which increases in proportion to the measures taken to cure it, gives occasion to that singular and admirable scene of the fourth act, which the necessity of unmasking a vice so abominable as that of hypocrisy renders indispensable. The panegyric of Louis XIV, put in the mouth of the exempt at the end of the play, could not justify the fault of the unraveling in the eyes of the critics. Here indeed is the insuperable difficulty. It is impossible to set on the stage a religious hypocrite and not lend him the language of piety. Consequently an attempt to tear the mask off religious hypocrisy must necessarily take on the occasional aspect of an assault on religion itself. This was the basis of the opposition to the play, and that it was in a measure justified is borne out by the subsequent use of 'Tartuffe' by aggressive enemies of any form of ecclesiasticism as though it were an assault on religion itself. There is an extremely clever translation of 'Tartuffe,' with the French text *en regard*, in the fifth volume of the works of Molière published by John Watts (London 1748).

HERBERT F. WRIGHT.

TASCHEREAU, tăsh'ĕ'rō, SIR **Henri Elzear,** Canadian jurist: b. 7 Oct. 1836; d. 1909. He was called to the Quebec bar in 1857, and was made queen's counsel in 1867. From 1861-67 he sat in the Canadian Legislative Assembly representing Beance County. In 1871 he was appointed judge of the Quebec Superior Court, and (1878) judge of the Supreme Court of Canada. He was created knight in 1902 and from 1902-06 was chief justice of the Supreme Court of Canada.

TASCHEREAU, Jules Antoine, French author and politician: b. Tours, 1801; d. Paris, 11 Nov. 1874. He studied law at Orléans, and entered journalism in Paris. After the overthrow of the Bourbons in 1830, to which he had contributed, he was named general secretary to the prefect of the Seine; and in 1837 he entered the Chamber of Deputies. Meantime he had established and continued to edit the *Revue rétrospective*. He was among the early supporters of Louis Napoleon, and after the *coup d'état* was rewarded with the post of assistant director of the National Library. In 1858 he was given the chief directorship. His permanent literary work consists of critical biographies of Molière, Corneille and Diderot.

TASHKEND, täsh-kĕnd', or **TASHKENT**, Asia, the capital of Russian Turkestan and of the province of Sir-Daria, formerly in the khanate of Khokand, a few miles from the Chirchik and about 40 miles from its confluence with the Sir-Daria or Jaxartes, in a fertile oasis. It is the most important city in Asiatic Russia, and is at the terminus of the Transcaspian Railway, with direct rail route to the Caspian Sea and to Orenburg. It consists of an old town and a new Russian quarter. Its former walls, which were 12 miles in circuit, are now in ruins. The streets in the old town are very narrow. not, however, in consequence of the crowding of the houses, but of the number of gardens and vineyards, whose walls aproach so nearly as to leave only lanes between them. The water led from the river by canals furnishes a copious supply to numerous fountains, and almost every house has its cistern and its bath. The principal buildings include several large mosques, a very extensive bazaar, numerous colleges and a number of old temples surmounted by cupolas. The Russian district of the city has broad streets lined with trees, electrically lighted and traversed by trolley lines, and contains gymnasia, a public library, observatory, museum, a citadel, various civil and military establishments, arsenals, etc. The inhabitants are employed in weaving silk and cotton goods, making articles in leather and felt, etc. The trade in corn, cotton, rice, etc., is very extensive. Tashkend was taken by Russia in 1865; about one-sixth of the present population of 272,000 is Russian.

TASK, The, a descriptive poem written by William Cowper (q.v.) in the summer of 1783, and published two years later in a volume containing also «An Epistle to Joseph Hill, Esq.,» «Tirocinium,» and «John Gilpin» (q.v.). It is in blank verse of excellent quality, though at times echoing Milton a bit too plainly, and it is distributed into six books, the aggregate number of lines being somewhat over 5,000. The metrical form and the theme with which he begins, «the sofa,» are said to have been taken by the poet from Lady Austen, who also told him the story of «John Gilpin,» and the title commemorates the fact that in writing he was obeying her injunction. The scenery, the descriptions of which have perhaps done more than anything else to make the poem a classic standing not far below the great elaborate poems of the language, is that of Olney, in Buckinghamshire, and the neighboring Weston. «The Task» set the seal on Cowper's popularity with his own generation and that succeeding, and without it, despite the extraordinary and too little recognized excellence of his shorter pieces, notable in range and quality, he would perhaps not rank so high as a poet to-day, although it is to be feared that too many readers know his masterpiece only through quotations, such as «God made the country, and man made the town.» «Variety's the very spice of life,» «the cups that cheer but not inebriate,» and the like, or else through selections such as the pathetic description of «Crazy Kate,» or the patriotic «England, with all thy faults I love thee still,» or the picture of the postman outside in the winter evening, while all is domestic comfort within, or the poignant bit of autobiography that begins «I was a stricken deer.» That the desultory and somewhat spun out «Task» with its longueurs, its exhibitions of intellectual narrowness and religious bigotry, its comparative lack of high and sustained imagination, should tempt to skimming and even to tasting by selections does not afford matter for surprise; yet the admirer of Cowper and the student of English poetry must contend that so to treat «The Task» is to stand in one's own light. The ease and skill of the transitions make the very desultoriness of the poem an exhibition of art, Cowper at his narrowest is still perhaps the most urbane of our poets, the descriptions of scenery are scarcely equaled, as etchings in words, whether by Thomson or by Wordsworth, and, although there is little of the latter's philosophic insight into the heart of nature and into that of man, there is in compensation the absolutely sincere expression of the observations, reflections and emotions of a sensitive poetic genius unspoiled by literary or social sophistication. When in addition we think of Cowper's playful humor, his feeling for domesticity, his humanitarianism, his satiric power — witness the passage on the excise in the fourth book — as exhibited in «The Task,» we are led to wonder whether our great-grandfathers in their hearty appreciation of the poem as a whole were not wiser than we are in our reservations and in our glib phrases with regard to Cowper's services as a precursor of the Georgian romantics.

William P. Trent.

TASMAN, täs'män, **Abel Janssen (Janszen, Janzoon)**, Dutch navigator: b. Hoorn, North Holland, about 1602; d. Batavia, Java, October 1659. He was engaged in voyages of discovery in the Pacific and Indian oceans in 1639–42 under the patronage of Van Diemen, governor-general of the Dutch West Indies, and in the latter year was sent to circumnavigate Australia. He sailed from Batavia 14 Aug. 1642, discovered on 24 November the island which he called Van Diemen's Land, but which has since been named Tasmania, and later discovered the southern island of New Zealand, the Friendly Islands, and the Fiji Islands and returned to Batavia 5 June 1643. Details concerning a subsequent voyage along the coasts of New Guinea and north and north-western Australia are exceedingly scanty. He set out on 29 Jan. 1644, discovered the Gulf of Carpentaria, made other important discoveries, and returned to Batavia, but further information is lacking. He ranks as one of the greatest navigators of the 17th century. He published a narrative of his first voyage which was reprinted in 1722 and in 1860. Consult his 'Life' by Walker (Hobart, Tasmania 1896).

TASMAN (tăz'mạn) **SEA,** Oceanica, that part of the Pacific Ocean lying between Tasmania (and southeast Australia) and New Zealand. It is 1,500 miles across, and is crossed by a submarine cable from Sydney to Wellington.

TASMANIA, tăz-mā'nĭ-ạ, Australia, the smallest state of the commonwealth, consisting of the island of Tasmania and its adjacent islets, and situated 140 miles south of the southeastern extremity of the Australian continent, from which it is separated by Bass Strait. The area of the state is 26,385 square miles, and of the main island 24,339 square miles. The main island is heart-shaped, about 180 miles long from north to south, and 175 miles at the widest. The coasts are bold and much indented, forming a number of excellent harbors. The interior is a plateau intersected in various directions by a number of rough and precipitous mountain ranges, rising in Cradle Mountain to a height of 5,069 feet. Some of the intervening basins contain large and beautiful lakes, and rivers are numerous. The geology is characterized by considerable outcrops of palæozoic rocks and extensive flows of tertiary basalt. The mineral wealth is great and mining is the principal industry. The annual value of mineral products is about $4,000,000, mostly gold, silver, copper and tin. The imports in 1916 totaled nearly $5,000,000 and the exports less than $4,000,000. The largest farm crop is oats, 2,000,000 bushels annually, wheat following with 1,000,000 bushels. The climate is temperate, and the rainfall in general sufficient. The flora and fauna are similar to those of southern Australia. There are two remarkable animals peculiar to the island, the Tasmanian wolf and the "Tasmanian devil" (*Thylacinus* and *Dasyurus*), sometimes called the native tiger. The soil is very fertile, especially in the basaltic regions, and well adapted for wheat, which is the principal crop. Grazing has declined, and the manufactures are inconsiderable. The volume of trade amounts to over $20,000,000 annually. The chief exports are copper, fruits, silver, wool, tin, gold, timber, hides and grain. Hobart, the chief port on the southeastern coast, has regular steamship connection with Europe, Australia and New Zealand. There are about 600 miles of railroads. Education is compulsory. There are 16 colleges, and at the head of the educational system is the University of Tasmania. The capital of the state is Hobart with 38,000 population.

Tasmania was discovered in 1642 by the Dutch navigator, Tasman, who named it Van Diemen's Land, after his patron. In 1804 England established a penal colony on the island. This was maintained until 1853, when Tasmania was declared a British colony. In 1900 it became a state of the commonwealth of Australia. The aboriginal inhabitants are almost extinct. There is a remarkable regular shifting of the population between Tasmania and Southern Australia, more than 40,000 emigrants and over 40,000 immigrants being officially recorded every year. Consult 'Statistics of Tasmania' (Hobart, Australia). See AUSTRALIA.

TASMANIAN WOLF, DEVIL, ZEBRA-WOLF, etc. See DASYURE.

TASSAERT, tā-särt, **Nicolas François Octave,** French painter: b. Paris, 1800; d. there by suicide, 1874. He entered the studios of Girard and Lethière and made it his especial artistic aim to portray 'Les Miserables' of Paris — the poor, the suffering, the unfortunate. The exaggerated sentimentality of his pictures was much admired at the time and his realism appealed even to Delacroix and Rousseau. Among his best-known works are 'The Old Musician'; 'A Family of the Unhappy'; 'The Slave Merchant'; and 'Death of Héloïse.'

TASSIE, tăs'ĭ, **James,** English gem engraver: b. Polloshaws, near Glasgow, 15 July 1735; d. London, 1 June 1799. During his early life he worked as a stonemason, then went to Glasgow where he studied art and became associated with Dr. Quin in gem engraving. With him Tassie perfected the discovery of a white "enamel," a hard vitreous paste, especially adapted to the formation of gems and medallions. Going to London in 1766 he became successful through the precision and beauty of his work, copied many of the most artistic gems of ancient and modern times and also made a series of large medallion portraits of many of the famous men of his time. These medallions are of great historic interest and are considered his most valuable work.

TASSO, tăs'sō (Eng. tăs'ō), **Bernardo,** Italian poet: b. Venice, 11 Nov. 1493; d. Ostiglia, 5 Sept. 1569. His education began in Padua, and was continued during his visits to Rome, Ferrara and Venice. He was already known as a poet throughout Italy when Guido Rangone, general of the Pope and a patron of learning, took him into his service and employed him in negotiations with Clement VII at Rome and Francis I in France. He subsequently entered the service of Renata, Duchess of Ferrara, but soon left her court for Padua and Venice. Ferrante Sanseverino, Prince of Salerno, engaged him, in 1531, as secretary, and when that prince followed Charles V to Tunis, Tasso accompanied him, and after his return was sent on public business to Spain. In 1539 he married the rich, beautiful and intellectual Porzia de Rossi, and retired to Sorrento, where he lived till 1547. But the misfortunes of his master, whose estates had been seized by Charles V on account of his opposition to the introduction of the Inquisition into Naples, compelled the poet, at the invitation of the Duke of Urbino, to take up his residence at Pessaro. The leisure which he now enjoyed was employed in finishing his 'Amadigi,' which he published at Venice in 1560. In 1563 the Duke of Mantua appointed him governor of Ostiglia. He was buried at Mantua under a monument erected by the duke, with the inscription "Ossa Bernardi Tassi," but his son Torquato afterward removed his remains to Ferrara. His chief work, 'L'Amadigi di Gaula,' a romantic epic, displays much talent and art. His other works, in five books, are among the best Italian lyric and elegiac poems of the time. Consult Pasolini, 'I Genitori di Torquato Tasso' (1895).

TASSO, Torquato, tōr'kwä'tō, son of the preceding, Italian epic poet: b. Sorrento, 11 March 1544; d. Rome, 25 April 1595. He was

TORQUATO TASSO

early sent to the school of the Jesuits at Naples, and his father being absent from home, his education was at first superintended by his mother, whom he quitted at 10 years of age to rejoin his father at Rome, and never saw her again. At this time he could recite from memory the great Greek and Latin poets. He subsequently pursued his studies under his father's superintendence at Rome, Bergamo, Urbino, Pesaro and Venice. Before the age of 16 he was employed by his father to revise and complete his poem 'L'Amadigi,' and eventually sent to Padua to study law. Tasso, a born poet, found his legal studies a sore burden, but managed to steal time for more congenial pursuits, and at 17, to the surprise of Italy and the indignation of his father, produced the 'Rinaldo,' an epic poem in 12 cantos. The disappointment of the father yielded at length to genuine admiration of this really remarkable production, and he consented to allow his son to abandon law for literature. The reputation of the young poet meanwhile procured for him an invitation to the University of Bologna, where he displayed an aptitude for the study of philosophy, especially that of Plato. He left Bologna on account of a lampoon, which he was unjustly charged with writing. After visiting friends at Castelvetro, Modena and Correggio, he returned to Padua on the invitation of Scipio di Gonzaga. Here he continued the study of Plato, and wrote three 'Discorsi del Poema Eroico.' He determined no longer to imitate Ariosto but take Virgil for his model. He began to construct the plan of his 'Gerusalemme Liberata,' which he at first called 'Godfredo.' The plan of this poem was of a highly prudential character. By celebrating all the great European houses as having taken part in the crusade of Godfrey, he hoped to make himself many powerful friends, and while he was elaborating this project he secured a patron in Cardinal Luigi d'Este, to whom he had dedicated his 'Rinaldo.' The princes of Italy at this time deemed it their chief honor to be esteemed the patrons of art and literature, and the cardinal retained 500 gentlemen in his retinue, one of whom was Tasso, who was also introduced by the cardinal to the court of Ferrara. The Academy of Ferrara supplied learned associates with whom he engaged in philosophical discussions; the courtiers were easily transformed into paladins, and the court ladies into heroines, whose imaginary achievements the poet recorded with daily diligence. Thus the 'Gerusalemme' grew at the court of Ferrara. That nothing might be wanting to his experience, the bard engaged in a course of love-making on his own account. There were at the court of Ferrara two sisters of the reigning duke, Lucrezia, the wife of the Duke of Urbino, and Leonora, the younger, a virgin of 30, and about nine years his senior. Their brother Alfonso served to the poet as model for his 'Godfredo.' In high favor with the ladies, by whom his attentions were received as the gallantries of a courtier and a poet, it would be impossible to imagine a more blissful slave than the poet had now become. In 1571 he accompanied the cardinal on an embassy from the Pope to Charles IX of France. He was received with distinction at the court of France, which he followed to Blois, Tours and Chenonceaux. Ronsard (q.v.) received him in the most friendly spirit. A quarrel with his patron drove him from the French court, and he returned to Ferrara, where Alfonso, at the solicitation of his sisters, received the penniless poet into his own service. In the spring of 1573 his 'Aminta,' a pastoral drama, was represented at the court of Ferrara. It is still considered the most graceful Italian work of the kind, although many prefer the 'Pastor Fido' of Guarini. In April 1575 he announced the completion of the 'Gerusalemme.' Alfonso was eager for its immediate publication, but this judicious counsel was not heeded by the poet, whose sensitive mind dreaded censure, especially the censure of the Church, even more than it coveted applause. He, therefore, sent his poem to his friend Scipio Gonzaga, now a cardinal at Rome, requesting his judgment. Scipio assembled a consulta of churchmen and critics against whose censures, literary and ecclesiastical, the poet was forced to defend himself and to amend and modify his work to meet their views. He was told he ought to be content with monks and nuns as his auditors, and to renounce all mythology, romance and chivalrous adventure, and his mind, divided between art and religion, gave way. To add to his distraction his work at this time was printed piratically without his own revisions. Alfonso wrote a vigorous protest against this disgraceful proceeding to all the Italian courts, but doubts of his favor at court began also to fill the mind of Tasso. He believed that he was persistently calumniated at court, and systematically misrepresented to the Inquisition. On 17 June 1577, he drew his poignard in the apartment of the Duchess of Urbino. He was arrested, but set at liberty after two days and recommended to retire to his country-seat. In spite of strong reassurances he still suspected the office at Rome. He was now received into the convent of Saint Francis at Ferrara, but on the 20th July he started in disguise for his native place where he stayed with his sister Cornelia, till the end of summer. In the autumn he solicited leave to return to Ferrara, and obsequiously accepted a conditional acquiescence to his request. Alfonso is accused of imprisoning him, first, from offense at the addresses paid to his sister; secondly, from jealousy of the Medici, from whom the poet had received an offer; and thirdly, from fear that the poet would strike the glory of the house of Este out of his work. For some years Tasso had lived on intimate terms with Alfonso and his two sisters, especially Lucrezia, who, dismissed by her husband, kept him as her constant companion. He had hesitated about accepting the offer of the Medici, but in 1557 he put away, out of gratitude to the Este family, all thoughts of other service. After many complaints of ill-treatment he again left Ferrara, and wandered, sometimes in want, through Padua, Venice, Urbino and Piedmont, and finally returned to Ferrara (21 Feb. 1579), on the eve of the duke's second marriage. Finding himself treated with complete neglect, he broke out in loud complaint and was imprisoned as a madman in the hospital of Saint Anne of Ferrara. At this time his work was condemned by the Academy della Crusca, to whom he replied with moderation. He remained in the hospital of Saint Anne till July 1586, when he was released at the solicitation of Vincent di Gonzaga, who took him to his estates. Tasso now resided at Mantua, and wrote the tragedy of Torrismondo, which with a genealogical poem he dedicated to Vincent di Gonzaga. Finding that Mantua did not agree with him, he proceeded to Naples, the climate of which he found most congenial, and where he fixed his favorite residence at the monastery of Mount Olivetto. Here he composed the 'Gerusalemme Conquistata,' which he dedicated to Cardinal Aldobrandini. It is a reconstruction of the 'Gerusalemme Liberata,' in which he rejects the chief mystical and chivalrous ornaments of the previous poem, and plumes himself on a precise and slavish imitation of the 'Iliad.' He wished it to supersede the 'Liberata,' but posterity has reversed his decision as to its superiority. Aldobrandini solicited and obtained from the Pope the laurel crown on behalf of Tasso. Urged by his patron, Tasso repaired to Rome, although he declared it was to die. Amid the preparations for the ceremony his health gave way. He retired from the plaudits of the public to the convent of Santo Onofrio, where he expired. (See AMINTA; JERUSALEM DELIVERED). Tasso's chief works include 'Gerusalemme Liberata'; the 'Rime,' and the 'Aminta.' The 'Gerusalemme' was translated into English by Edward Fairfax in 1600. In Italian literature the 'Gerusalemme' shares with the 'Orlando' of Ariosto the place of the greatest epic. Both are full of poetic beauties and admirable for the interest and variety of the narrative. Consult Albertazzi, A., 'Torquato Tasso' (Modena 1911); Boulting, W., 'Tasso and his Times' (New York 1907); Milman, R., 'Life of Tasso' (2 vols., London 1850); Ferrazzi, 'T. Tasso, studi biografici-critici-bibliografici' (1880); Serassi, 'La vita di T. Tasso' (3d ed., with notes by Guasti 1858); 'Complete Works' (33 vols., Pisa 1821–32); Tasso's 'Lettere e Dialoghi,' edited by Guasti (Florence 1852–59); 'Prose diverse' (1875); Solerti, A., 'Vita di Torquato Tasso' (3 vols., Turin 1895); de Sanctis, F., 'Storia della letteratura italiana' (2 vols., Bari 1912); Sainati, A., 'La lirica di Torquato Tasso' (Pisa 1912); Scopia, 'Le fonti del mondo creato di Torquato Tasso' (Naples 1907); Wagner, Hedwig, 'Tasso daheim und in Deutschland' (Berlin 1905); Woodberry, G. E., 'The Inspiration of Poetry' (New York 1910).

TASTE, *in æsthetics,* appreciation of the beautiful; the faculty of discriminating the qualities of beauty, harmony, etc., and exercising them, particularly in art and literature, joined to a capacity for appreciating and enjoying excellence. See ÆSTHETICS.

TASTE. See SENSES.

TATARS, or **TARTARS,** a nomadic people anciently spoken of as Scythians, known for their incursions and conquests among neighboring nations over a wide extent of territory; their local seat being found both in ancient and modern times in the steppes or uncultivated regions which connect Europe and Asia, as well as on the north of China, in Turkestan and on the shores of the Caspian and Black seas. Tartar, Tatar or Ta-ta appears to have been the name of a tribe of Mongols who occupied about the 9th century a district of Chinese Tartary on the upper Amur. This tribe was dispersed by the attacks of neighboring Mongols, and carrying the terror of its arms in different directions its name came to be applied by the Chinese to various hordes of Mongol robbers. The true Tatars formed part of the horde of Genghis Khan, when that conqueror carried his arms from the country known as Chinese Tartary to Europe, and through some accidental circumstance the name came to be applied to the whole Mongol horde, as well as to the successive hordes of similar origin who followed in their footsteps, and to the districts from which they came, or in which they settled; hence the names of Chinese Tartary, Independent Tartary (see TURKESTAN) and European or Little Tartary, comprising most of the Russian governments of Orenburg, Astrakhan, Ekaterinoslav, the Cossack provinces and the Crimea. For the incursions and conquests of these peoples see GENGHIS KHAN; MONGOLIA; RUSSIA, etc. The name Tatar has, for reasons similar to those already given, been long applied in Europe to the Manchu conquerors of China. The Manchus are Tatars in the generic sense of the term. See MANCHURIA.

TATE, tāt, **Alexander Norman,** English analytical chemist: b. Wells, Somerset, 24 Feb. 1837; d. Orton, Cheshire, 22 July 1892. He studied chemistry in Liverpool, where he established an analytical and consulting laboratory in 1863, and there became known to the world of industrial science in connection with the study of the recently introduced American petroleum. He wrote 'Petroleum and its Products' (1863), and superintended the erection and management of oil-refining works in the Isle of Man and in Flintshire until 1869. He finally settled at Hackins Hey and increased his reputation as an expert in the analyses of oils and fats, and as a teacher of science in the technical schools at Liverpool. He was editor of the scientific magazine *Research* (1888–90) and a contributor to scientific periodicals.

TATE, George, English archæologist and naturalist: b. Alnwick, 1805; d. there, 7 June 1871. He was a linen draper and subsequently postmaster of his native town and became celebrated for his scientific researches and his publications. These include 'The Old Celtic Town of Greaves Ash'; the 'Hut-circles and Forts on Yeverling Bell'; among the long list of valuable papers on the ancient remains of the district, its geology, flora and fauna, and 'Sculptured Rocks of Northumberland and Eastern Borders' (1865) and 'History of Alnwick' (1865–69).

TATE, Henry, English merchant and philanthropist: b. Chorley, Lancashire, 1819; d. Streatham, 5 Dec. 1899. He was a sugar merchant in Liverpool and amassed a fortune through the invention of loaf sugar. He removed to London in 1880 and became famous for his benefactions, giving £42,000 to the Liverpool University College, a still larger sum to Liverpool hospitals and four free libraries to the parish of Lambeth. He established a large private gallery of modern paintings at Streatham and afterward presented it to the public, building for the collection a gallery near Vauxhall Bridge, at a cost of £80,000. The institution, known as the "Tate Gallery," was opened in 1897, and its donor was created a baronet in 1898.

1. Sudanese Negr[illegible] W[illegible] [illegible] [illegible]lander.
[illegible] 6. [illegible] [illegible]apanese.

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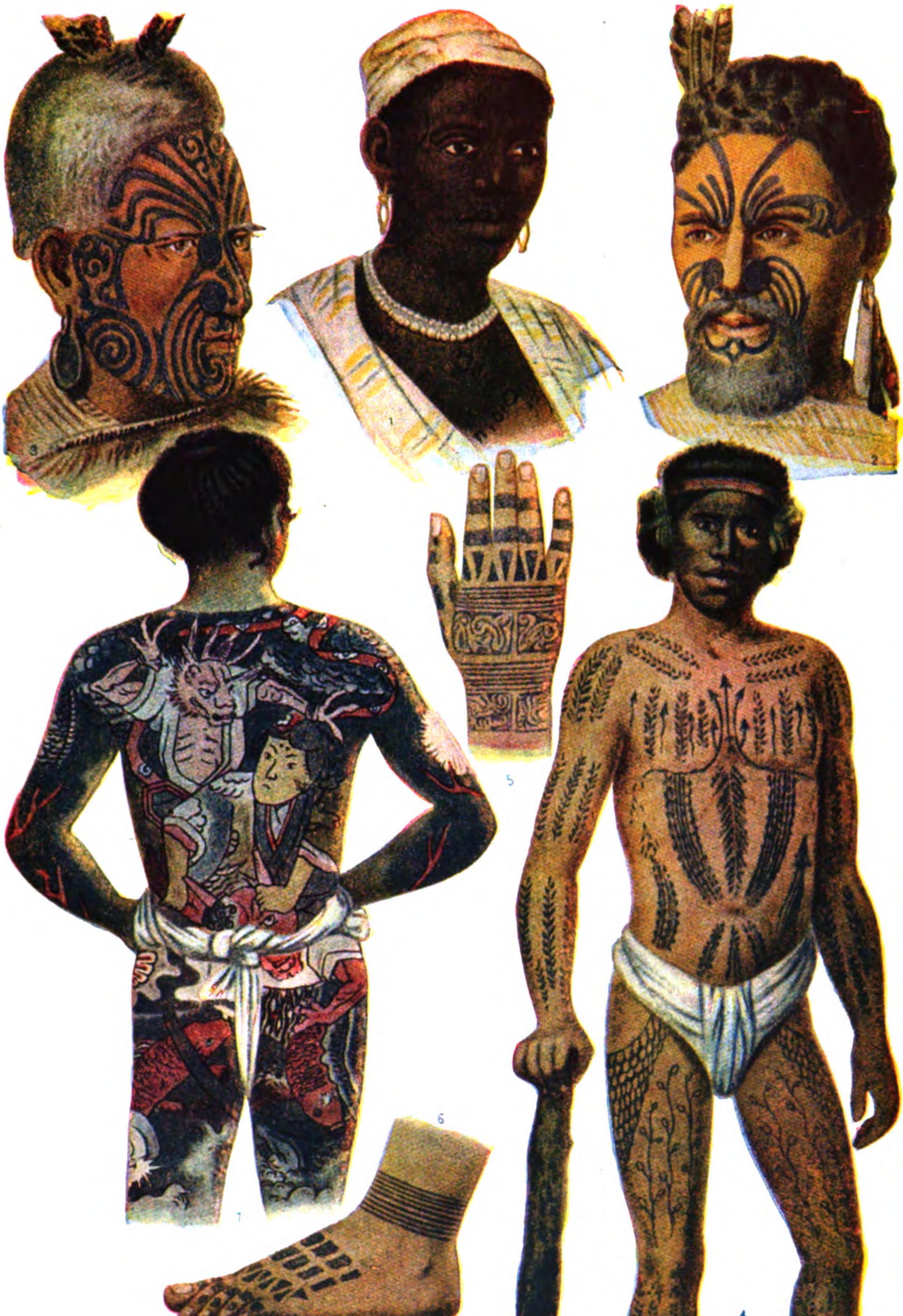
TATTOOING



1 Sudanese Negro Woman. 2, 3. Maoris of New Zealand. 4. Caroline Islander.
5, 6. Hand and Foot of a Dyak of Borneo. 7. Japanese.

TATE, Nahum, English poet: b. 1652; d. 1715. Son of a Dublin clergyman, he was educated at Trinity College. In 1690 he succeeded Shadwell as poet-laureate. Oldys calls him "a free, good-natured, fuddling companion." His name has survived through his metrical version (1696) of the Psalms, which he wrote in collaboration with Nicholas Brady, certain portions of which appeal to the reader, but most of which has no poetic value. He also wrote dramatic pieces, as 'King Lear' (an adaptation); 'Panacea or a Poem on Tea'; 'Miscellanea Sacra'; 'Innocent Epicure'; etc. The 'Supplement to the New Version' (1703) may have been due solely to his pen, in which the world-renowned "While Shepherds Watched" is ascribed to Tate.

TATIAN, tā'shĭ-an, Christian apologist: b. 2d century in Assyria; d. Edessa, 180. He studied Greek philosophy and became dissatisfied with the pagan systems of his time. At Rome about 150 he was converted to Christianity by the teachings of Justin Martyr (q.v.). His only surviving controversial work, 'Address to the Greeks,' was written 176 and after the death of Justin Martyr he adopted Gnostic Dualism and unchristian conceptions regarding God, the demiurge and the world of æons, and admitted the existence of contradictions in the Scriptures. In practical matters he rejected the use of wine and of animal food, and used only water in celebrating the Eucharist. He was also opposed to marriage, and he gave in his adhesion to the sect of the Encratites. He was answered by Tertullian, Clement of Alexandria, Hippolytus, Origen and others. His 'Diatessaron' was a kind of harmony of the four gospels. In 1876 Dr. Moesinger published at Venice a Latin translation of a commentary on the 'Diatessaron' which had been written by Ephraim Syrus. The translation had been made in 1841 by Aucher, a Mechitarist monk, not from the original Syriac of Ephraim, for that is not extant, but from an Armenian version ascribed to the 5th century. In 1881 Zahn published his 'Tatian's Diatessaron,' in which he sought to restore the work from the available materials. An Arabic version found in Egypt was edited in 1888 by Agostino Ciasca. The original language of the 'Diatessaron' may have been Syriac; Harnack believes that it was Greek. Consult Otto, 'Corpus Apologetarum' (1882); Hamphill, 'The Literature of the 2d Century' (1891); Harris, 'The Diatessaron of Tatian' (1890); Hill, 'The Earliest Life of Christ' (1893).

TATIUS, tā'shĭ-ŭs, **Achilles.** See ACHILLES TATIUS.

TATLER, The, a paper published by Sir Richard Steele in London, from April 1709 to January 1711. The name, Steele asserted, was invented in honor of the fair sex, and he wrote in it under the pseudonym of "Isaac Bickerstaff," used by Swift previously in his joke upon the almanac-maker, Partridge. Its announcement indicated its purpose to present "accounts of gallantry, pleasure and entertainment," and it may be taken as the first venture in magazine literature in English. Steele wrote 188 of the 271 papers issued, Addison 41, and together they produced most of the others. *The Tatler* was succeeded by *The Spectator* (q.v.).

TATTERSALL'S, tăt'ėr-sâlz, located in Knightsbridge Green, London, England, is the great metropolitan mart for horses, of which there is an auction every Monday throughout the year and every Thursday in spring. It has acquired greater celebrity as the headquarters of betting men.

TATTI, tät'tē, **Jacopo.** See SANSOVINO, JACOPO.

TATTNALL, tăt'nąl, **Josiah,** American naval officer: b. Bonaventure, near Savannah, Ga., 9 Nov. 1795; d. Savannah, Ga., 14 June 1871. He was educated in England and in 1811 returned to the United States, where the next year he was appointed midshipman in the navy. He was engaged in the battle of Bladensburg and served in the Algerine war in Decatur's squadron. He was promoted lieutenant in 1818 and was engaged in the suppression of the West Indian piracy under Porter in 1823–24. He was promoted commander in 1838, placed in charge of the Boston navy yard and at the outbreak of the Mexican War was assigned to the command of the *Spitfire* and joined the squadron at Vera Cruz. He took charge of the Mosquito division, with which he covered the landing of General Scott's troops, and after the fall of Vera Cruz led the attack on the forts at Tuspan. He became captain in 1850 and in 1857 was appointed flag-officer of the Asiatic squadron, where he participated in an attack with the French and British on the Chinese. Although a violation of neutrality, he was sustained by public opinion and also by the government. In 1861 he resigned from the United States navy and offered his services to the governor of Georgia. He was appointed captain in the Confederate navy, took command of the *Merrimac* after the engagement with the *Monitor* in 1862 and set out for Hampton Roads. After the surrender of Norfolk and the navy yard he withdrew with the *Merrimac,* and on 11 May 1862 to prevent her capture sunk her off Craney Island. The court-martial, which he requested, after a thorough investigation acquitted him from all blame. He then engaged in the defense of Savannah River, but in 1865 was compelled to destroy his vessels. In 1870 he returned home and was appointed inspector of the port of Savannah, a post which he occupied until his death. Consult Jones, C. C., 'Life of Commodore Tattnall' (1878).

TATTOOING, a word of Polynesian origin, anglicized from the Tahitian *tatu,* denoting the practice of making permanent colored designs or figures in the skin by means of small punctures or incisions, which receive various dyes or pigments. The coloring is mainly dark blue and dull red. A similar custom, known as cicatrization or scar-tattooing, consists in repeatedly cutting the skin at the same place so that in healing a raised scar is left. Both varieties of tattooing may be found among the same people, as in the case of the natives of the South Sea Islands. Among the Admiralty Islanders, the Fijians, the Gonds and the Todas of India, the inhabitants of the Liu-Kiu Islands and other races, color-tattooing is, or was, confined to the women, and the Latuka of the upper Nile Valley are an example of a people among whom scar-tattooing is practised upon women only. Color-tattooing is generally ornamental, but scar-tattooing is more frequently used to produce distinguishing tribal marks. The latter variety is practised by a number of native African peoples, while the Bangala of the Middle Kongo scar the whole body for ornamental purposes. In some races there is a connection between tattooing and marriage. Thus, in the Solomon Islands a girl is not eligible for marriage until she has been subjected to an atrociously cruel process of tattooing on the face and chest, and the native Australians inflict fearful scars on the backs of their young girls before marriage. The Formosans tattoo the faces of girls prior to marriage; and among the Papuans of New Guinea unmarried girls are tattooed all over, except on the face, which is adorned in this way at the time of their marriage. Color-tattooing of an ornamental kind reached its most artistic development among the Maoris of New Zealand and the Japanese, but both these peoples, like several others, have largely abandoned the practice under the influence of civilization. With the Malays tattooing appears to have been a reward of the successful head-hunter. Sailors and some other classes in civilized countries do some tattooing, mainly in one color, making figures, as stars, flags, etc., on their hands, arms, chests, etc. Consult Robley, H. G., 'Moko, or Maori Tattooing' (London 1896).

TAUCHNITZ, towH'nĭts, **Christian Bernhard,** Freiherr von, German publisher: b. Schleinitz, near Naumburg, 25 Aug. 1816; d. 13 Aug. 1895. In 1837 he founded his well-known publishing establishment in Leipzig; in 1860 was created a hereditary noble; in 1866 was appointed consul-general for Great Britain in the kingdom of Saxony; and in 1877 was made a life member of the Saxon first chamber. The firm is best known for its Collection of British and American Authors,' generally called the "Tauchnitz Edition," begun in 1841 and in 1903 extending to about 3,700 volumes.

TAUCHNITZ, Karl Christoph Traugott, German printer and bookseller: b. Grosspardau, near Grimma, 29 Oct. 1761; d. 14 Jan. 1834. In 1797 he set up a printing shop at Leipzig, which he enlarged by the addition of a book-shop in 1798 and a type-foundry in 1800, the style of the firm being Karl Tauchnitz. He first introduced stereotyping into Germany, and won a high reputation by his musical publications, his editions of the Bible and the Koran and his remarkably correct series of Greek and Latin classics.

TAULER, tow'lĕr, **Johann,** German mystic: b. Strasburg, about 1300; d. there, 16 June 1361. At 18 he renounced a fortune to enter the Dominican cloister, where he studied the scholastic theology, and returning to Strasburg came under the influence of Master Eckhart, whose vernacular sermons then attracted thronging audiences. He was the more impelled to mystical and fervent piety by the violence of the war between Pope John XXII and the Emperor Louis the Bavarian, when the bishop of Strasburg forbade the clergy to open their churches. He became one of the so-called "friends of God," an unorganized brotherhood, including priests, nobles and burghers in all the large cities, who represented the height of mysticism, denied the special prerogative of the clergy except in the celebration of the sacraments, and with anti-sacerdotal tendencies dwelt upon worship in the heart and life. He preached with wonderful success in Strasburg and in the neighboring towns, villages and convents. Notwithstanding the papal interdict and amid the ravages of the black death (1348–49) he bestowed the consolations of religion on the forsaken people, preaching in German mingled with Latin. He published in German a treatise on 'Following the Lowly Life of Christ'; addressed a remonstrance to the clergy against leaving the dying untended and unabsolved; and denounced ecclesiastical abuses while maintaining the claims of the electors. His mysticism, though it pronounced silence and suffering the most perfect work, was rather active than passive, taught explicitly the love of others, tended not to asceticism but to the amelioration of society, recommended the discharge of all ecclesiastical duties as a preparation for a higher stage of spiritual perfection and was opposed to the pantheistic tenets of Eckhart and the Beguins. The best of the early editions of his sermons are those of 1498, 1521–22, 1523 and 1543. The hymns and treatise on German theology which have been attributed to him are of doubtful authenticity. Consult Schmidt, 'Johannes Tauler von Strasburg' (1841); Winkworth, 'Life and Times of Tauler, with 25 of his sermons translated from the German' (1857); Junot, 'Les Amis de Dieu au XIVe Siècle' (1870).

TAUNTON, tân'tọn, England, a market town of Somerset, on the Tone, 36 miles by rail south-southwest of Bristol. The principal buildings and institutions are the parish churches of Saint James and Saint Mary Magdalene; an old grammar-school, reconstructed; a Wesleyan Methodist and a Congregational College; a mechanics' institute; and the castle, still in good preservation, and containing the museum of the Somersetshire Archæological and Natural History Society. The industrial establishments include silk-factories, glove and paper-box works, iron and brass foundries, coach-works, breweries, etc. Taunton is of great antiquity, and from the discovery of urns containing Roman coins appears to have been a Roman station. During the Civil War it was defended by the Parliamentarians against the Royalists. The inhabitants suffered much from the rebellion of Monmouth, whose cause they espoused, and who assumed the title of king here on 20 June 1685. Jeffrey (q.v.) held his bloody assize here in the same year. Pop. 22,563.

TAUNTON, Mass., city, county-seat of Bristol County, at the head of navigation on the Taunton River, and on the New York, New Haven and Hartford Railroad, about 36 miles southeast of Boston and 16 miles north of Fall River. Over 100 passenger trains and about 100 freight trains enter the city daily. The Fall River line of steamers, which have daily connection with New York and other places, are so easily reached that practically Taunton has daily communication by water with many of the Atlantic ports. The city gets its coal, iron and lumber at tide water, and freight rates to and from Taunton are less than for inland cities. Electric lines connect the nearby villages and towns with the city, more than 700 cars leaving centre of the city daily.

The city is noted for the extent and variety of its manufacturing industries. The government census of 1910 gives the leading manufacturing establishments of the city as follows: seven cotton mills, with $4,410,390 invested, and employing 3,151 persons, to whom were paid annually $1,125,679. The cost of the material used annually was $2,651,502, and the value of the yearly products was $4,592,466. There were 14 foundries and machine shops, with capital invested, $2,679,203; the value of their yearly products, $2,636,390. The total number of manufactories (1909) was 146; the total capital invested, $16,504,000; the annual average number of employees, 7,835; the annual amount of wages, $4,535,000; the cost of material used, $7,775,000; and the value of the products, $15,380,000. The principal manufactures, besides cotton products, are cutlery, machinists' tools, eyelets, tacks, nails, jewelry, machinery for cotton manufactories, silver and britannia ware, brick, oil-cloth, copper and yellow metal goods, printing presses, stoves, stove linings and kitchen utensils. The city is the distributing centre for a large part of Bristol and adjoining counties; coal is shipped from here to the markets of the interior, and grain, vegetables, poultry and manufactures to outside markets.

The principal public buildings are the State Insane Hospital, a massive group of buildings, situated in a tract of 140 acres, which accommodate over 1,000 patients; the county courthouse (cost over $300,000); Registry building (cost $125,000); the government building ($100,000); city hall; Taunton jail; theatre; Odd Fellows' Hall; Historical Hall; Morton Hospital, the gift of Susan Tillinghast Morton Kimball; Old Ladies' Home, opened January 1871; club buildings, banks, business blocks, schools and churches. There are six each of Congregational and Roman Catholic churches, four Methodist, one each of Unitarian, Baptist, Presbyterian, Christian Scientist, Adventist, Protestant Episcopal and Universalist. The educational institutions are Bristol Academy, opened 18 July 1793; Saint Mary's Academy (Roman Catholic); headquarters of the Old Colony Historical Society, incorporated 4 May 1853; a high school, public and parish schools, graded elementary schools and a public library containing about 55,000 volumes. The city is well supplied with bank institutions; the two national banks had, 1 Sept. 1910, a combined capital of $700,000; the combined surplus of two savings banks was $8,335,000; and five co-operative banks had a combined capital of over $3,000,000. The government of the city is vested in a mayor and nine councilmen chosen by popular vote. Pop. about 36,161.

History.— The first white settlement was made by Elizabeth Pole, an Englishwoman, in 1637. She found here an Indian village called Tecticutt («great river») on the Tecticutt River. Miss Pole bought land from the Indians for a plantation on the east side of the river, within the present limits of Ward Four. The place was first called Cohannet, but when it was incorporated in 1639 it was called by its present name, after Taunton, England. In June 1639 Taunton sent deputies to the General Court assembled at Plymouth. The names which appear on the Taunton records — of men connected with the surveys and the granting of titles — are names of men who were among the history makers of the nation. The early settlers of Taunton recognized the rights of the Indians, and the records show that Miss Pole and others purchased lands from Massasoit and other Indians. William Hooke, the first minister, returned to England as domestic chaplain to Oliver Cromwell. The first mention of a schoolmaster is that of Master Bishop, who was one of the early settlers. Other schoolmasters were William Pole, Mr. Adams, James Green, and in 1683, Samuel Danforth, a minister, was selected to keep a «Gramer scole here in Taunton.» In 1647 an act was passed which made the public schools free and the support of the schools compulsory. In 1682 Taunton received from the court £3 from the funds of the fishing excise of the Cape, for keeping a free colonial, classical and elementary school. In 1701–02 100 acres of land, on both sides of the river, were set apart for school purposes. The history of education in Taunton is an almost complete history of the city. A grist mill was erected in 1639–40; in 1653 the first successful iron works in America were established. Some of the products of the iron works were used as money, as may be seen from the following order:

To the Clerk of the Iron Works,
Ensign Thomas Leonard please pay to Bar' Tipping nine shillings and three pence in iron money.
From yr friend,
Richard Williams.
Taunton 16th 1st — 1685.

In 1659–60 a saw-mill was built, and before 1700 brick making, shipbuilding and many other industries had been begun. The ruins and sites of many of the old manufactories are pointed out as of historic interest; for they mark the beginnings of the mighty industries of the Taunton of the present. On 6 Nov. 1746 the place was made a «shire town,» and on 2 Jan. 1865 was incorporated as a city. The first crucibles in America were made here; the copper blank discs for copper cents were supplied to the government, in large amounts, by the Taunton Manufacturing Company. Taunton has always furnished promptly more than its quota of soldiers when the country called for defenders. In 1774 the people unfurled from the liberty pole on «Taunton Green» a flag, on which was inscribed «Liberty and Union»; and among the «minnit men» at Lexington, 19 April 1775, was a brave band from Taunton. They were among the first to go and the last to return. Robert Treat Paine, one of the signers of the Declaration of Independence, resided here, for whom a statue has been erected in front of the city hall. Consult Waterman, 'History of Taunton Schools'; Emery, 'History of Taunton' (1893); 'Quarter-Millennial Celebration of the City of Taunton.'

TAUNUS, tow'noos, Germany, a mountain range mainly in the Prussian province of Hesse-Nassau, extending eastward from the Rhine, north of the Main, separating the basin of that river from that of the Lahn. The highest summit, Grosser Feldberg, is 2,886 feet in elevation. The district is well wooded, and exhibits much picturesque scenery, as well as ruined castles, etc., and antiquarian remains dating from Roman times. Its scenery and mineral waters attract many visitors; and some of the finest German wines are grown on the south side. The point of most historical interest in the region is the ancient Roman fort uncovered at Saalburg, showing fortifications dating back to the year 200. West of Saalburg the Germans erected a colossal statue of Germania to celebrate their victory over France in 1870–71.

TAURIDA, tow'rē-dā, a government of the Ukrainian Republic, bounded north by Ekaterinoslav; east by the Sea of Azov; southeast, south and west by the Black Sea; and northwest by the government of Kherson, from which it is separated by the Dnieper; area, 23,312 square miles. It is irregular in shape, and being united to the land only on its boundary with Ekaterinoslav for about 90 miles, may be regarded as one large peninsula, subdivided again into two minor peninsulas, of which that in the south, now called the Crimea, and well known in ancient times as the Chersonesus, is the more perfect; the isthmus which connects it with the northern portion being at its narrowest not more than eight miles. The northern peninsula consists almost entirely of an extensive steppe, which stretches across into the southern peninsula. It is generally without a tree, and in many parts composed of parched and saline sands, where vegetation is almost extinct; but in other parts is composed of fertile loams, capable of raising any kind of crop, and often covered with verdant pastures. Simferopol is the capital city. (See also the article CRIMEA). Pop. about 2,133,000.

TAURUS, tâ'rŭs, Asiatic Turkey (or Asia Minor), a mountain chain or series of mountain groups usually considered as beginning in the east on the Euphrates, at the Nushar Cataract, in the pashalic of Marash, whence it stretches west, nearly parallel to the coast of the Mediterranean, for above 500 miles, terminating to the north of the Gulf of Adalia. In the east it takes the name of Jebel-Kurim, or sometimes Anti-Taurus Mountains, in the west that of Ramadan Oglou Balakar. It sends off several branches, of which the most remarkable are Alma-Dagh, which proceeds south into Syria, and becomes linked with the chain of Lebanon; and the Anti-Taurus, which proceeds northeast, sending out ramifications which become linked with Ararat, Elburz and Caucasus. Many of the Eastern peaks are above 10,000 feet.

TAURUS, the Bull, *in astronomy,* a name given the second of the zodiacal constellations. It contains the star of the first magnitude Aldebaran (in the eye), the group of the Pleiades (in the neck), and the Hyades (in the face).

TAUSEN, Hans, Danish reformer: b. Birkende, on Fünen Island, 1494; d. Ribe, 11 Nov. 1561. He studied at Wittenberg and was preacher, from 1525, at Viborg, then, from 1529, at Copenhagen. He edited, with collaborators (1530), «The 43d Copenhagen Article.» In 1535 he published a prayer-book and a book of homilies. He was appointed reading-master of the university (1537) and (1542) bishop of Ribe. Instead of Latin he used his native language in his sermons and books. A selection of his works was brought out by Rördam (Copenhagen 1870). Consult Rön, 'Skiagraphia Lutheri Danici M. Johannis' (1757); Schmitt, L., 'Johannis Tausen, oder der dänische Luther' (Köln 1894).

TAUSIG, Karl, German pianist: b. Warsaw, 4 Nov. 1841; d. Leipzig, 17 July 1871. First he was under his father's tuition, then studied under Bocklet, Thalberg and Liszt in Vienna. He made art tours, then lived in Dresden and later (1861–62) in Vienna. From 1866 he was royal court pianist at Berlin and led, till 1870, an academy of pianoforte playing. As a virtuoso he was equally interpreter of classic as of modern piano-music, but as composer he produced few works. Noteworthy of his productions is his edition of Clementis' 'Gradus ad Parnassum.' His piano score of Wagner's 'Meistersinger' became very popular. His 'Technischen Studien' was published by H. Ehrlich. Consult Weitzmann, 'Der letzte der Virtuosen' (Berlin 1868).

TAUSSIG, tows'ĭg, **Edward David,** American naval officer: b. Saint Louis, Mo., 20 Nov. 1847. On graduating from the United States Naval Academy in 1867, he was appointed successively ensign, master and lieutenant, being made lieutenant-commander 19 June 1892. He has served on the European and Pacific stations and in the coast survey. He took possession of Wake Island for the United States and was placed in charge of Guam 1 Feb. 1899. He was on duty in the Philippines and during the summer of 1900 in North China. He has commanded the *Bennington* and the *Yorktown.*

TAUSSIG, Frank William, American political economist: b. Saint Louis, Mo., 28 Dec. 1859. He was graduated at Harvard in 1879, and has been full professor of political economy there since 1892. He has written 'Tariff History of the United States' (1st ed., 1888; 6th ed., 1914); 'Silver Situation in the United States' (1892); 'Wages and Capital' (1896); 'Principles of Economics' (1911); 'Some Aspects of the Tariff Question' (1915); 'Inventors and Moneymakers' (1915), and has been editor-in-chief of *The Quarterly Journal of Economics.*

TAUTOG, a marine fish (*Tautoga onitis*) of the Atlantic Coast of the United States, related to the cunners and wrasses of the family *Labridæ*, and locally known as blackfish or oysterfish. It is from two to three feet in length, when large, blackish or greenish in color, the young with about three pairs of obscure dark bars; chin white; eye greenish. It abounds about weedy rocks, oyster reefs, etc., near shore, feeding on mollusks, barnacles, etc., and is easily caught. It is one of the best table-fishes of the American coast. The annual catch off the New England coast is about 750 tons.

TAVERN, a name common especially in the rural districts of Great Britain and the United States for a village inn or hotel. Occasionally some city hotel has borne the name.

TAVERNIER, tā-vĕr-nē-ā, **Jean Baptiste,** BARON D'AUBONNE, French traveler: b. Paris, about 1605; d. Copenhagen, 1689. Before his 21st year he had visited a considerable portion of Europe. He subsequently traveled through Turkey, Persia and other Eastern countries, six times by different routes, trading as a diamond merchant, and studying manners and customs. Of his journeys he gave an account, with the assistance of a literary friend. In 1689, having realized a large fortune and obtained a patent of nobility, he retired to the estate of Aubonne, in the Genevese territories, with the view of passing there the remainder of his life. But altering his determination, he was preparing to start once more for the East, when he was suddenly overtaken by death. His travels, 'Voyages en Turquie, en Perse, et aux Indes,' of which there are translations in English (1678 and 1684), Dutch (1682) and German (1684), have gone through several editions in the original French.

TAVOY, tā-voi', Burma, (1) a town in Tenasserim, on the river of the same name, capital of a district, 35 miles from its mouth, 230 miles southeast of Rangoon. It is situated on Tavoy River, about 30 miles from the harbor sheltered by Tavoy Point, a conspicuous peninsula on the Burma coast. It lies in a low situation, which, during the rainy season, becomes almost a swamp. It is laid out in straight streets, and the houses are mostly built of timber and thatched with palm leaves. The trade is inconsiderable. Near the town a mass of native loadstone occurs, and at a short distance from it is a hill entirely composed of specular iron ore. Pop. about 25,063. (2) An executive district which has been under British control since 1824, with an area of 5,308 square miles; pop. about 110,000. (3) An island about 75 miles south of the town of the same name, the largest and most northern of the extensive chain which is called the Mergui or Tenasserim Archipelago. It is about 18 miles long and two broad, and its southern part is surrounded by numerous shoals and small islands, which make navigation dangerous. On the eastern side there is a good and well-sheltered harbor, which has received the name of Port Owen.

TAWAS (tâ'wạs) **CITY**, Mich., village, county-seat of Iosco County, on Tawas Bay (an inlet of Lake Huron), at the mouth of the Tawas River, and on the Detroit and Mackinac Railroad, about 66 miles north of Bay City. It has a good harbor and steamer connection with many of the lake ports. It is in an agricultural and lumbering region, and nearby are large salt deposits. Its industries are connected chiefly with the manufacturing of lumber, and the shipment of salt, lumber and farm products. There is one bank. Pop. about 1,000.

TAWI TAWI, tä'wĕ tä'wĕ, Philippines, (1) A group of islands of the Sulu Archipelago, forming the extreme southwestern part of the Philippines, consisting of 88 islands; area, 462 square miles. Some of the islands, though charted, are unnamed; the others are divided into three sub-groups or clusters; (*a*) the Cinapusan or Kinapusan cluster; (*b*) the Tawi Tawi cluster; and (*c*) the Laparan cluster. The larger islands are mountainous, but of moderate height; the valleys and plains are fertile and covered with tropical vegetation. Rice, corn, hemp and coffee are cultivated, but only for domestic use; the forest wealth is considerable, but is not of commercial value on account of lack of means of transportation. The chief industry is fishing, pearl fishing and gathering of mother-of-pearl, etc. The islands are sparsely populated and, as many are very inaccessible, have been for many years the hiding places of pirates; the few settlements were mostly established by the Spaniards. (2) The largest and name island of the Tawi Tawi group; length from northeast to southwest, 35 miles; greatest width, 15 miles; area, 187 square miles. It is mountainous, and of volcanic formation; they are three groups of two peaks each, one at the southern end, one at the northern end and the third in the east central part; greatest elevation, 1,941 feet. The soil is generally fertile, and the island well wooded; the chief industry, as in the rest of the group, is fishing. The chief settlement is Tatán, on the northwest coast, on a small bay.

TAWNEY, James A., congressman: b. near Gettysburg, Pa., 3 Jan. 1855; d. Excelsior Springs, Mo., 12 June 1919. He was educated at the common schools and learned the blacksmith's and machinist's trade. He went to Winona, Minn., in 1877 and worked there as a machinist for four years. He was admitted to the bar there in 1882 and practised law until 1890, when he was elected to the State senate of Minnesota. In 1893 he was elected to the 53d Congress and served continuously until 1911, when he was defeated by the Progressive party. Mr. Tawney was appointed by ex-President Taft to the International Joint Commission created by treaty with Great Britain for the settlement of disputes between the United States and Canada, and was chairman of the United States section of the commission until his death. Mr. Tawney had great political power in Minnesota, and took an active part in anti-trust legislation. In 1906 he was vice-chairman of the Republican Congressional Campaign Committee. He was known in the Republican party as an insurgent and continually surprised the Republican machine while in Congress by bolting. He was an orator of great power. He was chairman of the House Appropriations Committee until 1910, and long championed a Federal budget system. Tawney was defeated for re-election in 1910, when he opposed reform of the power of the speaker of the House. In 1910 he opposed the efforts of the Republicans to increase appropriations for the army and navy.

TAX ASSESSORS. See TAXATION.

TAX-DEED, an instrument or conveyance whereby the proper officer of the law undertakes to convey the title of the rightful owner to the purchaser at a tax sale or a sale of the land for non-payment of taxes. This deed, according to the principles of the common law, is simply a link in the chain of the purchaser's title. It does not of itself transfer the title of the owner, as in grants from the government of deeds, or as do conveyances between individuals. The deed is not the title itself, or even evidence of it, its recitals not being binding. No presumption arises upon the mere production of the deed that the facts upon which it is based really existed, but when it is shown that the officers of the law have performed every duty imposed upon them the deed becomes conclusive evidence of the title in the purchaser.

TAXALES. See PALEOBOTANY.

TAXATION. What Is a Tax? — A distinction must be made between a tax and the exercise of the power of taxation. Property may be taken from individuals by the government in the exercise of various sovereign powers, such as the power of eminent domain, the penal power, the police power and the taxing power. Where the purpose of the compulsory payment is neither to exercise the right of eminent domain nor to inflict punishment nor primarily for purposes of regulation, we have to deal with the power of taxation. The power of taxation may be exercised, however, in several ways. The government may perform a service for the individual from which a specific benefit is received and where the cost of the service is presumed to be covered by the payment. Such payments are called fees or tolls. Or, again, the government may, with or without the consent of the individual, make an improvement which increases the value of his real estate and may impose what is technically called a special assessment or a betterment charge. Finally, the government may impose a payment on the individual where the special benefit, if any, is merely incidental. Such a payment is called a tax. Taxes in the narrower sense are to be distinguished, therefore, not only from fines and penalties as well as from prices (charges made by the government when it carries on a commercial or industrial undertaking) but also from fees or tolls and from special assessments, both of which are equally manifestations of the taxing power, but which are distinguished from taxes in the narrower sense in that the special benefit accruing to the individual is both positive and measurable.

A tax may, therefore, be defined as a compulsory contribution from the person to the government to defray the expenses incurred in the common interest of all, without reference to special benefits conferred. Each word in this definition is significant. A tax is a contribution, whether in money or in kind; it is compulsory (to distinguish it from a gift); it is paid by a person — either a natural person, like an individual, or an artificial person, like a corporation; it is paid to the government in any of its forms, whether local, State, Federal or international; the expense must be incurred in the common interest of all or, in legal parlance, it must be for a public purpose; otherwise it is confiscation, not taxation. Finally, it must be paid without reference to special benefits conferred. It is levied for the common benefit, not for any special benefit.

The Reason of Taxation.— By the reason of taxation is meant the ground or the philosophical justification of taxation. The older theory may be called the exchange or the contract or the reciprocity theory. It was connected with the 18th-century contract theory of the state. This theory holds that taxes are a mere exchange between the individual and the government, that the government performs certain services like that of protection, for the individual and that the individual gives the government something in return. This theory has been completely superseded by the more modern political philosophy. The modern theory may be called the organic theory of taxation. It does indeed not deny the obligation of the government to do something for the community in return for the payment exacted from the community. In this sense, there is, indeed, reciprocity; but it is an exchange between the community as a whole and the government which represents the community. It is not an exchange of any kind between the state and the individual. Modern political philosophy does not recognize the contract theory. The individual does not contract or bargain with the state. He is born into the state, or, if he transfers his political allegiance, he does so without any reservations. In this sense the state is as much a part of the individual as the family is a part of the individual. Just as the individual involuntarily assumes certain obligations to his family, so he assumes obligations to the state of which he is a member. It is, therefore, as much his duty to support the state as it is to support his family. In fact, we may go further. The state or politically organized community is indispensable to modern civilized man. We cannot conceive of any one living outside of the state. Since no one can throw off the obligations of the state — which can in the last instance demand a man's very life — it is as much the duty of the individual to support the state as it is to support himself. The obligation to pay taxes may, therefore, be declared in modern times to be a natural obligation and the state is everywhere justified in converting this moral obligation into a legal obligation.

The Function of Taxation.— The primary function of taxation, therefore, is to raise revenue. This may be declared to be the fiscal function of taxation. As a matter of fact, however, taxation has always been used for other purposes which may be declared to be secondary or incidental in character. Such a function may be declared the social, rather than the fiscal, function of taxation. Taxation has been at various times employed to check, to prohibit, to destroy or to foster economic activity. At the present time, in the United States, for instance, we have a tax which completely prohibits the issue of State bank notes and certain kinds of future sales on the cotton exchange. We have a tax designed materially to check the import of opium. We have a tax which has utterly destroyed the production of phosphorus matches. We have, or have had, taxes designed to foster or protect certain forms of domestic industry. In this respect there have been two extreme schools of thought, the one represented in the United States by statesmen like Calhoun or publicists like David A. Wells, who have contended that the only function of taxation is fiscal and that protection, for instance, means confiscation. The other extreme represented by certain socialists and by professorial socialists like Adolf Wagner, have maintained that the primary purpose of taxation is to effect changes in distribution. A logical corollary of this position would be that no payment can be considered a tax unless it seeks to effect social changes. The more modern and more moderate position is that while the primary function of taxation must be the fiscal function, there is no reason for refusing to bring about, incidentally, through taxation, desirable social reforms that are recognized as such by the community.

The Nature of Taxation.— Is taxation a good or a bad thing? Is it a benefit or an evil? Here again we have two schools of thought. The older writers, of whom Jean Baptiste Say is a good example, adopted the so-called consumption theory of public finance, and held that governmental functions ought to be reduced to a minimum and that the exercise of governmental power represents the unproductive consumption of the community. The consequence is that all government expenditures should be reduced to a minimum and that, as it has been said, the best tax is the smallest tax. At the other extreme is found the statement which is based upon the productivity theory of public finance. According to this the state is, or ought to be, the chief productive force in the community because, at all events, it is designed to lay the foundations for the exercise of all individual production. Everything extracted from the individual and spent by the government would from this point of view, as it has been put, return in a fertilizing shower to the community. Taxation would, therefore, be the best form of investment.

Here again the modern position is midway between the two extremes. It is undeniable that a tax involves a burden or a sacrifice and in this sense it is something which to that extent represents an evil. But it is equally true that the result of the tax is, or may be, to enable the government to accomplish something which is of undeniable advantage to the community as a whole, even though the particular benefit which accrues to the individual may not always be definitely measureable. The real question, therefore, is: what is the result of the expenditure or what does the government do with the tax? If the expenditure is a foolish or a wasteful one, if no care has been taken in limiting either the end or the means, there can be no doubt that the tax represents an evil. But if the object to be attained is economically or socially desirable, if the money is economically spent and if the balance of the social advantage over the social sacrifice is clear — if, in other words, the government is efficiently carrying out a wise mandate of the people — then the tax represents a good and not an evil. To say that the best tax is the least in amount would bring us back to primitive savagery. On the contrary, the distinguishing mark of modern civilization is the growing proportion between the satisfaction of collective wants on the one hand as over against the satisfaction of individual wants on the other. The more civilized the community the greater, not only absolutely but relatively, will be the amount of taxation as compared with the total social income. While, therefore, it is by no means true that every tax is a good tax or that every expenditure is a wise expenditure, it is nevertheless a fact that in the sense indicated above taxation is a good rather than an evil because it is a necessary means of accomplishing certain desirable political and social aims. The nearer, in other words, every tax comes to being an ideal tax, the more will it represent a balance of benefits over disadvantages.

The Limits of Taxation.— Even though taxation in the above sense may be declared to be good, there is another sense in which there is a definite limit upon the possible advantages of taxation. We have here to consider taxation not, as above, in relation to the returns to be expected, but in relation to the source from which taxes are derived. It is a question not what do you do with the tax, but from what source do you get the tax? In other words, no matter how ideal in other respects a tax is, it may impose too heavy a burden upon the community. The limits of taxation may be legal, political or economic. The legal limitations upon taxation are creatures of positive law. The government, in the United States for instance, is enjoined from levying a tax on exports. The State governments are prohibited from levying any taxes which will interfere with interstate commerce. Both State and local governments are frequently enjoined from levying more than a maximum rate of taxation. The political limits of taxation may be illustrated by the provision of American law, that all taxes must be for a public purpose. The exact formula of what constitutes public purpose is something which has given great trouble to our judges and publicists. The economic limits of taxation are seen when we reflect that the ultimate source of all taxes is the social income and that the demands preferred by government in the form of taxation may trench unduly upon this income. We have had numerous examples both of megalomania and of unwise expenditure in the history of American finance, especially State and local finance. Not a few communities have even become bankrupt through the impossibility of raising sufficient revenue by taxation to defray the present and past expenditures of the community. In the last resort, the community, like the individual, must cut its coat according to its cloth. It may conceivably levy taxes up to the limit of the social income, but if it exceeds that income or trenches upon the capital-replacement fund of the community, it marks the beginning of a backward step in economic progress.

The History of Taxation.— In the history of taxation there is discernible the influence of four sets of causes. First and most significant are the general economic conditions. The fiscal system is always in large part a reflex of the economic system. When economic conditions are simple, the forms of taxation are apt to be simple. Where there is a preponderance of certain economic factors, the tax system will vary accordingly. Thus, in the American colonies, there were three fundamentally different systems of taxation, corresponding to the system of small farms and petty industry in the New England colonies, to the dominance of business interests in the middle colonies and to the plantation system in the Southern colonies. The fiscal system of the feudal ages rested largely upon land. The success of the tax on personal property was and is very different in the towns from what it was in the country. The growth of modern forms of business has brought with it an entirely new system of taxation. Second to be emphasized is the influence of democratic factors. Modern democracy and the changed attitude to the laboring classes has brought with it a considerable alteration in the kinds of taxes and in the proportion between the so-called direct and indirect taxes. The same influence is attributable to the introduction of the modern system of progressive taxation. In the third place, we note the development of the idea of faculty or ability to pay. More and more the system of taxation has been molded by the desire to fit the burden to the capacity of the contributors and the tests that have been progressively employed to measure faculty have, as will be seen below, undergone a continual modification. In the fourth place, side by side with the adoption of individual faculty we note the substitution of the social for the individual treatment in taxation, that is, a system modified by a study of the social consequences and economic effects of the tax system upon the various economic classes in the community as a whole.

Influence and Effects of Taxation.— The effects on production. Here again two theories stand opposed to each other. A former school contended that taxes stimulate production. It had been claimed by some that a new tax evokes a new ability to bear the tax and that in this sense an increase in the seeming burdens may really augment the industry of the people. It has been argued that if industry in general is the result of coping with the natural disadvantages, such as the inclemencies or difficulties of nature, why should not the same result be brought about by artificial disadvantage, like taxation? Attention is directed to the period of the Napoleonic wars where the increase of British taxes seemed to result in greater power to bear the taxes. On the other hand, we find the contention that all taxes are injurious, or, as in the case of the Single Taxers, that all taxes excepting the land value tax exercise a deleterious influence because they are taxes on labor and industry and, therefore, check or repress labor or industry.

The truth again lies in the midway. It is undoubtedly a fact that some taxes seem to increase industry. But if regarded more attentively it will be seen that the tax is the occasion, rather than the cause, of the redoubled activity and in that in almost all cases the lure of profit rather than the fear of loss is the real stimulus to productivity and invention. It is undoubtedly far more frequent that industry is injuriously affected, rather than benefited, by the burden. But it by no means follows that every tax exerts an injurious result. If certain principles of equality are observed, it is possible for a tax to be innocuous so far as the producer is concerned, and, at the same time, to have the consumer benefit more from the results of the government outlay than he suffers from the tax. There is no broad generalization to be framed in this respect. According to the character of the particular impost, taxation may be said to have educational, destructive or regulative effects. There are two points of more general influence. One is connected with the inequality of taxation. If an exclusive or unequal tax is imposed upon some permanent source of revenue, the tax or the excess of the tax over the normal rate will be amortized or capitalized into the diminution of the selling value. If 1 per cent is assessed upon securities, for instance, which bear 5 per cent interest and have been selling at par, the new purchaser will pay only about 80. This is known as the capitalization of taxation. The same tendency of things to seek their level is found in the imposition of a new tax in general. A French writer, Canard, had laid down the principle that every new tax is a bad tax and every old tax is a good tax. What he meant was that the disturbance of industry by the imposition of a new tax often takes some time to allay itself. This of course must not be misinterpreted into the belief that a tax which is inherently bad can ever become good through the lapse of time. The effect of taxation on exchange of wealth is marked. The chief reason, for instance, why there is no large class of real estate dealers in Paris as compared with New York is the existence of a high tax on the transfer of land. It has sometimes been alleged that the downfall of Spain is due to the universal tax on sales, *alcavala,* in the Middle Ages. An important principle connected with the influence of taxation on exchange is the so-called excess-of-price doctrine. In its original form the doctrine held that every time a taxed commodity changed hands the tax grows in arithmetical proportion, for as the profits of each dealer are added to the price, the tax is imposed in each case successively on the new price, including the profits. This alleged principle, however, is open to the objection that according to modern economic theory, profits are not a part of price, but the result of price and that the price is always fixed at the point of minimum cost. The element of truth contained in the principle is due to the fact that interest is a part of cost and that to the extent that interest on the successive prices is of any importance, the tax tends to be cumulative. The influence of taxation on distribution is indisputable. Many taxes are designed to have such an effect, as high inheritance taxes, graduated income taxes, but many taxes also have unexpected effects on distribution. One of the older theories or "leave-them-as-you-find-them" doctrine states that the ideal tax ought to leave every individual in the same relative position as before the imposition of the tax. This is no longer accepted as an ideal.

The influence of taxes on consumption is of less importance than in former times. In the Middle Ages sumptuary taxes were very common. It was, however, not luxurious consumption, but necessary consumption, which was frequently sought to be hit. The ease with which taxes of certain kinds may be made to check consumption are so pronounced that it is primarily in periods of war finance that recourse is taken to this medium.

The political effects of taxation are no less important than the economic. The history of free government itself has been intimately influenced by the effects of taxation.

Incidence of Taxation.— By the incidence of a tax is meant its final resting place. We must distinguish between the impact of a tax or its original assessment, the shifting of a tax or its transfer, and the incidence of a tax or its final resting place. Shifting is the process, incidence is the result. The person who bears the tax is not always the one who pays the tax in the first instance. This has led some writers to lay down the so-called equal-diffusion theory of taxation, the theory, namely, that the body economic is like any organism and that if a liquid is injected into the veins at any point it will at once be diffused throughout the body. The tax, therefore, no matter where imposed, will be shifted to the community at large. This theory suffers from undue generalization. It is true that certain taxes give rise to such changes in economic relations that they may in a sense be said to be ultimately spread over the community. There are, on the other hand, many taxes which do not lead to this phenomena and some taxes which are not shifted at all. A distinction must furthermore be observed between capitalization and shifting. If a tax is shifted, it cannot be capitalized; if it is capitalized, it cannot be shifted. There are certain conditions which predispose to the shifting of taxation. The more general a tax is the less likely is it to be shifted because the smaller the tax the less the field to which the individual can betake himself. Where commodities are produced under varying conditions, much depends upon whether the tax is imposed upon the marginal or the intra-marginal producer. Where a tax is imposed upon land which produced a commodity with a local market, the tendency is for the tax to be shifted to the consumer. If the tax is imposed on the North Dakota farmer whose wheat is sold in Liverpool, the shifting of the tax depends upon the relative cost of producing Argentine or Russian wheat and upon the existence or absence of equal taxes in those countries. Where a tax is imposed not upon commodities or property in particular, but upon profits or income in general, the tendency to shift is much less pronounced. With taxes upon a particular kind of commodity or upon a particular kind of income, the situation is different.

The shifting of the tax is of importance not only as between producer and consumer, but also as between borrower and lender. In taxes imposed upon mortgages or upon funds borrowed the incidence of the tax depends to a large extent on whether the tax is general or exclusive. If the tax is levied as a part of a general income tax, it will not be shifted; if, however, it is an exclusive or unequal tax, either by law or in actual operation, the tax will ordinarily be shifted from the borrower to the lender. A complete study of the shifting of taxation would involve a treatise on the formation and distribution of wealth.

Principles of Taxation.— There are four different sets of principles of taxation, fiscal, administrative, economic and ethical. The *fiscal* principles are those of adequacy and elasticity. Unless a tax is sufficient to bring in the revenue that is needed or expected, it cannot be pronounced successful. Again, unless a tax is so elastic as to respond to the varying changes in economic conditions, it is also to be deprecated. The *administrative* principles of taxation are those of certainty, of convenience and of economy. Unless a tax law is certain in its provisions, it is a bad law. There is a great difference, for instance, between the certainty of a land tax and the uncertainty of a comprehensive or of a complicated income tax. The principle of convenience of taxation includes the question of how the tax is to be paid, when it is to be paid, where it is to be paid, and under what conditions, inquisitorial or otherwise, it is to be paid. The economy of taxation implies that a tax should take out of the pocket of the people as little as possible above what it brings into the government, or, in other words, that the cost of collection should be low. The *economic* principles of taxation may be declared to be innocuity and efficiency. The innocuity or harmlessness of a tax is a most desirable attribute. All taxes, indeed, represent a burden but, as has been pointed out above, certain taxes have a far more destructive effect than others. Other things being equal, the legislator must chose the most innocuous tax. By the efficiency of taxation is meant the capacity of a tax to accomplish the desired result. Many a tax is admirable in other respects, but can be made to work in practice only with difficulty. The present property tax, for instance, in the United States is to-day no longer an efficient tax. The *ethical* principles of taxation are those of uniformity and universality. As these are the most important, they will be discussed separately.

Uniformity or Equality of Taxation.— By equality is of course not meant absolute numerical equality, but relatively proportional equality. Uniformity, in other words, means relative uniformity. The question then arises as to the relation involved. To what should taxes be relative, in order to be equal? In former times the answer was that the real basis of taxation should be either the cost of service to the government or the value of the service to the individual. The more modern theory maintains that taxes should be in some relation to the faculty or the ability of the individual to pay. Much time has been spent upon the problem of what constituted the real elements of faculty. For a long time faculty was stated in terms of sacrifice. By equality of taxation there is meant an equality in the sacrifice imposed upon the individual. In more recent times, however, emphasis has been put upon another aspect of the problem. Sacrifice has to deal with the phenomenon of parting with one's wealth. It involves the question of what is left for immediate consumption after the tax has been paid. But economic life deals not only with consumption, but with production. When we come to consider the production of wealth rather than the consumption of wealth we are confronted by the facts of opportunity or privilege in the amassing of wealth. A man's ability to pay a tax, therefore, must be considered not only from the point of view of consumption but from that of production. In other words, the two elements of faculty are privilege and sacrifice: the easier it is for a man to make his money, the more ability he has to pay taxes; the harder it is for a man to be deprived of his money, the less ability he has to pay taxes.

The Norm of Taxation.— By the norm of taxation is meant the test of faculty. There have been no less than five such tests disclosed in the history of taxation: (1) The first test of faculty was polls. Everyone was supposed to have an equal ability to pay. In a primitive form of society the poll tax was legitimate. It has virtually disappeared to-day except in a few democratic communities like the United States, where it still lingers as a survival of a former and more primitive equality. (2) Expenditure. The advantage of expenditure as a test is that no one can escape because everyone spends something. The disadvantage of expenditure as a sole test of faculty is that some people must spend all they make, while others can save most of what they make. Expenditure thus becomes an increasingly unsatisfactory test of faculty; (3) Property. In a comparatively early form of society wealth in terms of property is an excellent test of faculty. The general property tax is accordingly found everywhere at a certain stage of development. The more complicated and the more differentiated the society, the more apparent, however, are the shortcomings of this test. The chief modern defects of property as a test of equality in taxation are the following: (a) While it is generally true that capital is nothing but capitalized income, there is in modern times frequently a discrepancy between the property and the yield or produce of the property. This may be due to speculation, to chance or to other accidents of economic life; (b) In modern times more and more wealth is derived from personal earnings rather than from property. The property tax would hit the owner of a $10,000 farm but leave untaxed the recipient of a $100,000 professional income; (c) There is a great difference between the legal and economic concept of property. Economically a man's wealth measured in terms of capital is his surplus over debts. Legally, property is independent of the debts. I may own a $10,000 farm even though I have borrowed $8,000 on the farm. The property tax frequently fails to make allowance for debts; (d) The concept of property fails to distinguish between consumption and production property. The property tax makes no distinction between the lawyer's library which contributes to his income and a bibliophile's library which may be a source of expense. 4. Product. The difficulties with the concept of property as a test of faculty led to the substitution of yield or produce as the proper test. Almost everywhere at a certain time the general property tax on the individual was, therefore, replaced by a series of taxes on the things themselves, measured by their product. Instead of a general property tax we now find a land tax, a capital tax, a business tax, a wage tax, etc. Produce is in some respects a more satisfactory test of faculty than property: it gets closer to the realities. But in the course of time a weakness disclosed itself in that not enough attention could be paid to the individual conditions of the recipient of the produce. 5. Income. The modern world has, therefore, come in large measure to an acceptance of the fifth test of faculty, which is that of income rather than of property or of produce. The tendency is accordingly strong for the replacement of the older taxes by modern taxes on individual income and business profits.

Graduated Taxation.—A further refinement, however, of the idea of faculty is seen in the growth of graduated or progressive taxation. Proportional taxation is giving way to graduated or progressive taxation because of the realization of the fact that graduation, although a technical breach of uniformity, really involves a higher uniformity. Progressive taxation is now almost everywhere recognized even in American jurisprudence, as involving no inequality of taxation. A graduated tax is a tax the rate of which increases with every unit of the base. The entering wedge of the theory of progress in taxation is found in the minimum-of-subsistence doctrine, the doctrine, namely, that a certain amount of income should be exempt from taxation because that minimum is indispensable to existence. This wedge was soon pushed further in so that emphasis was placed upon the element of sacrifice. The sacrifice involved in taking by taxation $100 from a man with a $1,000 income was recognized to be far greater than the sacrifice involved in taking $10,000 from the man with a $100,000 income. In one case the tax trenches upon the necessities and in the other it affects only superfluities. After some time, however, the conception of sacrifice was re-enforced by that of privilege. The difficulty of making the first $1,000 of a man's fortune is far greater than that of making subsequent accretions. All modern democracies are accordingly fast developing graduated or progressive taxes.

Differentiated Taxation.— The principle of faculty in taxation results not only in graduated taxation but in what is called differentiated taxation. Graduated taxation implies a change in the rate according to the amount of the income of property; differentiated taxation implies a change in the rate according to the kind of income of the property. The chief example of differentiated taxation is the distinction between what Great Britain calls earned and unearned incomes, i.e., taxation from property at a higher rate than income from labor. Other countries, however, like Italy, pursue the idea somewhat further and distinguish between property incomes, mixed incomes and labor incomes,— mixed incomes being incomes from business where both capital and enterprise are needed. The Federal income tax of the United States embodies the principle of graduated taxation, but has not yet accepted that of differentiated taxation. Where the distinction is made in the property tax rather than in the income tax, we are in the habit of calling it classification of taxation rather than differentiation of taxation. The movement for a classified property tax in lieu of the general property tax is making great headway in the United States. Classification for purposes of taxation has been upheld by the United States Supreme Court as involving no derogation from the constitutional principle of uniformity or equality of taxation.

Principle of Universality.— The other outcome of the doctrine of faculty is universality of taxation. Equality of taxation means among other things that all people should bear their burdens; that everyone should be taxed, and that no one, in contradistinction to his neighbor, should be taxed more than once. The modern world permits exemptions from taxation, but modern exemptions are different from those of former times. The mediæval exemptions were class exemptions and were, therefore, reprehensible. Modern exemptions rest upon presumed lack of ability to pay or upon considerations of public policy. They are permitted, not primarily for the benefit of the individual, but for the benefit of the community. While, with the exception of these justifiable exemptions, everyone should be taxed, it is equally important to avoid double taxation. Double taxation, or duplicate taxation, is of two kinds. It may be imposed by the same jurisdiction or by competing jurisdictions. An example of double taxation by the same jurisdiction is the simultaneous taxation of property and income. Ordinarily, to tax property is virtually to tax the income of the property. To tax the income again will then be double taxation. Where the purpose is to distinguish between earned or unearned incomes or to secure differentiation of taxation, where, in other words, the design is to tax property incomes more than other incomes, this form of double taxation is legitimate. Another example of double taxation is to tax the corporation and also the shareholder or to tax both the property and the mortgage on the property, because under the ordinary conditions of American life a tax on the lender will be shifted to the borrower so that the borrower will pay the tax not only on his own property but on that of the lender. Double taxation by competing jurisdictions is found when the same individual or piece of property is simultaneously taxed by different jurisdictions. An Englishman receiving his income from an American business may be taxed in the United States because the income is earned there; and taxed in Great Britain because he resides there. An American who dies in one State owning railway shares deposited with a trust company in another State, the chief office of the railway being in a third State and the railway line itself running through a fourth State, may conceivably be subject to taxation on the same property in all four States. The avoidance of such double or multiple taxation is possible either, on the one hand, by international agreement or the exercise of interstate comity or, on the other hand, as in some federal governments, by a federal law or ruling which apportions the tax among several states according to equitable principles.

Classification of Taxes.— There are many different ways in which taxes can be classified, according to the criterion employed. If emphasis is put upon property in which taxes are paid, we have taxes in kind and taxes in money. If the criterion is frequency of payment, they may be classified in terms of ordinary and extraordinary taxes. If the criterion is the rate of taxation, we may distinguish between apportioned and percentage taxes. A percentage tax is a tax like the income tax where the rate or percentage is known in advance; an apportioned tax is a tax like the real estate tax in the United States where the rate is arrived at as the result of an apportionment. According to the mode of levy, we may distinguish between taxes on persons and taxes on things. According to the method of measurement we may distinguish between assessed and expenditure taxes or between taxes on acquisition, on possession or on consumption. According to the methods and results of payment we may distinguish between direct and indirect taxes. This distinction is not very exact. It originated in the idea that where the taxpayer and the taxbearer were the same individual, the tax was a direct tax and, if they were different individuals, it was an indirect tax. The difficulty with this, however, is that the individual who would ordinarily transfer a commodity to someone else might consume it himself. The suggestion was, therefore, made to relegate the distinction to the intention of the legislator. Here again, however, we are met with the fact that the legislator frequently has no intention in the matter or that his intention is unknown. Some European writers, therefore, have contended that the criterion should be found in the permanence of the tax. If the tax is a recurring tax or if the phenomenon on which the tax is imposed is recurring, it is indirect, otherwise it is direct. In general, however, it may be said that by direct taxes are meant taxes on pollo, property or income, and by indirect taxes are meant taxes on consumption and on transactions.

The American Tax System.— The American tax system is composed of two elements — the State and local system and the Federal system. The State and local system has gone through several stages. At the end of the 18th century the slight revenue that was needed by the States and localities was derived chiefly from fees, together with poll taxes, taxes on land and taxes on a few articles of personal property. The land taxes were levied first according to quantity, then on gross produce or location and finally according to selling value. The separate property taxes gradually developed into a general property tax, which became the chief source of State and local revenue — the State tax being added to the local tax before the annual rate of taxation was determined. With the progress of society and especially with the growth of intangible personalty, personal property slowly slipped out of the assessment lists, so that the general property tax again became in fact, if not in law, a real property tax in great measure. This led, in the third quarter of the century, to an attempt to tax personal property through special taxes on certain corporations. Toward the close of the century the corporation taxes were supplemented by inheritance taxes. In several States liquor license taxes were added. Only in the Southern States do we also find a system of business or occupation or so-called privilege tax, as a survival of the Slavery system, where the plantation owners attempted to roll off the taxes on urban occupation.

The addition of corporation and inheritance taxes did not entirely solve the problem of the personal property tax. A two-fold movement accordingly developed in the 20th century. On the one hand we find the tendency toward the classified property tax, with lower rates for certain classes of personalty like money, securities, mortgages, etc. On the other hand came the movement for the replacement of the personal property tax by the income tax. Wisconsin took the lead in 1911, Massachusetts followed in part in 1915 and New York imposed a corporate income tax in 1916 and a personal income tax in 1919. Several other States have followed their example. The trend is now strongly toward a system whereby real estate will be taxed for local purposes and the State revenues be derived from an income tax, an inheritance tax and a corporation tax, part of the proceeds of which will be distributed to the local divisions.

The Federal tax system has also gone through several stages. At the beginning the Federal revenues were derived from import duties as well as from a variety of internal excises — including for a short time also a direct tax on land and on slaves. The advent to power of the Anti-Federalists in 1802 caused an abandonment of the so-called internal revenue taxes. From that year until the Civil War the sole reliance of the government was on import duties, except during the period of the war with England when the internal revenue taxes were restored. Shortly after the outbreak of the Civil War a comprehensive system of internal revenue taxes was initiated. These were abandoned one by one after the close of the war until only the taxes on tobacco and liquor remained. This system of import duties together with a few internal excises existed, with a slight interruption during the Spanish War, until 1909. In that year began the fourth period — the supplementing of the tariff by direct as well as by indirect internal taxes. First came the corporation tax in 1909, then the income tax in 1913. With the advent of the World War, finally, there came not only the reintroduction of many indirect internal taxes but also the inheritance tax and the excess profits tax as well as taxes on expenditure. Of these the two former are likely to remain permanently.

Thus while the land tax will continue to be levied primarily by the States, while import duties can be imposed only by the Federal government, and while internal taxes on commodities will probably be reserved more or less exclusively by the Federal government, the income tax, the inheritance tax, the business or excess profits tax and the corporation tax will probably be imposed by both Federal and State governments. The great problem of the future will thus be the fiscal relation of State and Nation.

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EDWIN R. A. SELIGMAN,
McVickar Professor of Political Economy and Finance, Columbia University.

TAXIDERMY is the art of stuffing and mounting the skins of animals, or their heads, so as to appear natural and lifelike. It is no longer a question of filling out a skin, but rather of making a statue of a creature long since dead, which will exactly fit the skin of that particular creature, stand erect and pose as the counterpart of life. "Taxidermy, the handmaid of zoology," said Dr. J. A. Allen, "has already become one of the fine arts, requiring the skill and other qualities of both the sculptor and the painter, and capable of yielding results comparable with the masterpieces of either." It is, however, one of the newest of the arts, and there is serious need of a well-established school of taxidermy in connection with some one of our great museums. Prior to 1880 only one American museum (the National) maintained a corps of taxidermists, and the majority of the mounted birds and mammals which found their way into other American museums were mounted at Ward's Natural Science Establishment, by men from France and Germany. Methods were crude and results were far below the standards attained a few years later. Much of the work produced prior to 1880 has since been either dismounted and remounted or else destroyed.

In March 1880, at Ward's establishment in Rochester, N. Y., Messrs. Hornaday, Webster, Lucas, Martens, Bailly, Critchley and Fraine organized the National Society of American Taxidermists and seriously began the task of developing taxidermy up to the level of the fine arts. All jealousy and exclusiveness were swept aside and the three competitive exhibitions that were held in Rochester, Boston and New York finally opened the eyes of scientific men and of the general public also to the possibilities of scholarly taxidermy, when properly encouraged and paid for. The upward impetus then gained has already carried American taxidermy beyond the original hopes of the founders of the society and the museums of America are now being filled with mounted vertebrates that in large measure are not only of real educational value but are also agreeable to the eye. No modern American museum is now complete without a well-equipped department of taxidermy, in charge of a chief taxidermist on a salary, which in 1880 would have been considered unattainable.

In a modern, high-class taxidermist, the first requisite is not a knowledge of methods in mounting, but the thorough education of the eye in animal forms and expressions. This must be secured by courses in drawing, modeling, carving and painting. The skeletons and external muscles of animals must be well studied, the latter from life. Besides the making of numberless sketches from life, hundreds of live-animal photographs should be collected and arranged for reference. Casts of heads and special parts of dead animals are of great importance and should be diligently collected. At all times must the natural history of the vertebrates be studied and kept in mind. When this preparatory work has been accomplished the aspirant for taxidermic honors must secure admission to the laboratory of some master-taxidermist and work with him to acquire a knowledge of methods.

A comparison of American with European taxidermy is of but passing interest, chiefly for the reason that without an international exhibition it is impossible to draw parallels of positive value. From three inspections of European zoological museums, made in 1876, 1896 and 1902, it is the opinion of the writer that the best of our museum taxidermy is now decidedly in advance of the best to be found in Europe. The groups of mammals, great and small, that now are so intensely interesting to visitors in the museums of Washington, New York, Pittsburgh, Chicago, Milwaukee and at the University of Kansas, have no counterparts in Europe. The British Museum of Natural History at South Kensington contains a fine series of groups of birds, mounted with natural accessories. In the museum of the Amsterdam "Natura Artis Magistra," there are a number of excellent groups of birds. In the museums of the American cities mentioned above the huge family groups representing the bison, moose, elk, caribou, musk-ox, deer, antelope, eland, zebra and other animals, all provided with carefully-studied natural accessories, constitute enduring monuments to the skill of American taxidermists.

Of all museum officers who have actively promoted the development of American taxidermy, Prof. Spencer F. Baird and Dr. G. Brown Goode stand first. As early as 1880 they advocated the attainment of perfection in results, regardless of time or cost. It was by their consent and co-operation that the National Museum set the pace in the development of large groups of mammals, which really began in 1887 with the group of American bison. In this connection honorable mention is due Prof. Henry A. Ward, founder of Ward's Natural Science Establishment, for the far-reaching influence exerted by him for the improvement of taxidermic methods generally and the co-operation which he extended to the Society of American Taxidermists.

With the improvements noted in museum taxidermy, equal advances have been made in the class of what is known as custom taxidermy. The number of trophy heads of large mammals that are now mounted annually in the United States cannot be less than about 1,800. About two-thirds are heads of deer and the remainder consist of moose, mountain-sheep, caribou, elk, antelope, mountain-goat, buffalo, musk-ox and bear, about in the order named. Twenty-five years ago a finely-mounted head was a rarity, but to-day, outside of the workshops of amateurs, a badly-mounted head is seldom seen. The standards of excellence have risen very greatly. The demands of patrons are more intelligent and good work is better compensated than heretofore.

As the world's mammals, birds and other vertebrates decrease, museums multiply, and the desire to provide fine collections becomes more earnest and insistent. Taxidermy now offers a good field for a limited number of young men of real artistic instincts who can bring to it adequate education and training and unlimited capacity for hard work.

Some important American works on taxidermy should be enumerated: Hornaday, 'Taxidermy and Zoological Collecting' (1892); Davie, 'Methods in the Art of Taxidermy' (1894); Rowley, 'Art of Taxidermy' (1900); Reed, C. K., 'Guide to Taxidermy' (Worcester 1908).

W. T. Hornaday,
Director New York Zoological Park.

TAXING DISTRICT. See District.

TAXONOMY IN PLANTS, derived from the Greek words ταξὶς *taxis*, meaning arrangement, and νομος, *nomos*, law. Called sometimes taxology. It is the study of classification, especially from a biological aspect, and treating of the morphology of plant life. Ray (1703) divided the vegetable kingdom into two general classes: the Flowering and the Flowerless, basing everything on one single characteristic. Endlicher, a little over a century later, formed the plant world into two groups: *Cormophyta* and *Thallophyta*, but the division was very imperfect and overlapping. Later we find two groupings by Linnæus under the titles: *Phanerogamia* and *Cryptogamia*, the former having flowers with stamens and pistils, the latter flowerless, seedless and propagated by spores. But the designation *Cryptogamia*, still retained by a few, their generative method being no longer *cryptic* (occult) or hidden from our present advanced knowledge. *Thallophyta*, still remaining in general use, no longer describes the class formerly considered by the expression. Thus with ever-increasing knowledge of the life-workings of the plant realm bringing new facts we have had to change repeatedly the system in taxonomy to bring the additional facts into close relation. And so the system of Ray gave way to the Endlicher, the latter to the greatly improved system of Linnæus (1735) with its 24 classes divided according to the number and disposition of the stamens, with variant orders according to the number of styles or stigmas, etc. This method of systematization, proving its deficiencies ever more with a deeper investigation of plant nature, had to give way (1813) to the Candolle system, soon to be displaced by the Sachs method of classification with its seven divisions, *Protophyta, Zygophyta, Oophyta, Carpophyta, Bryophyta, Pteridophyta, Phanerogamia.* The Sachs system is much in use to this day, but the most recent classification of botanists, based on the great advances brought about by microscopic and other researches into the plant structure, which keep disclosing weaknesses of the former system, are the following four main classifying divisions: (1) *Thallophyta;* (2) *Bryophyta;* (3) *Pteridophyta;* (4) *Spermaphyta.* The first three belong to the *Cryptograms*, the latter to the *Phanerogams.* It is an improvement generally considered better suited to the enlarged range of the botanist's vision; but already criticism is creeping in and taxonomy in plants may be subjected soon authoritatively to a further revision.

(1) *Thallophyta.* This division includes all of the four primary classes, the uni-cellular organic growth, having root, stem and leaf undefined. Under this head come the algæ, fungi, bacteria and lichens. (See Botany). (2) *Bryophyta.* These include the mosses and liverworts (*hepatica*), with distinct sexual organs in some, but in this division (as above stated) is the liverwort and other plants of the thallus type. (See Bryophyllum). (3) *Pteridophyta.* These are often termed *vascular cryptogams* and include, chiefly, the ferns with their propagation by spores. Their stem, leaf and root are clearly defined. (See Pteridophyta). (4) *Spermophyta* or *Phanerogams.* These are lately being divided into *angiosperms* and *gymnosperms* and the *angiosperms* are subdivided into *dicotyledons* and *monocotyledons.* The *Spermophyta* are the highest division of plants including those having true flowers and seeds. They are for the most part land plants, while many of the former divisions are aquatic. Their female cell (*oospore*) is fertilized in propagation and, protected by the *ovule*, becomes a seed, the seed formation being the characteristic of this group (termed also seed-

plants). *Gymnosperms* of this division have unisexual flowers, naked ovules with direct pollen fertilization, etc. (See GYMNOSPERM). *Angiosperms* have a closed seed vessel (*carpel*) and other distinguishing characteristics. See PLANTS, CLASSIFICATION OF.

TAY, tā, (1) a river in Scotland, in the county of Perth, formed by two head-streams, the one issuing from the northeast end of Loch Tay and the other from Loch Lyon, a small lake on the borders of Argyllshire. The two streams unite about two miles northeast of Loch Tay, whence the river flows past Aberfeldy, Dunkeld and Perth, at which last town it widens out into an estuary from one to three miles in breadth, becoming the northern boundary of the county of Fife. The whole length is 120 miles and the area of basin 2,250 square miles. Vessels of 500 tons ascend to Newburgh and those drawing nine feet to Perth. Its principal tributaries are the Tummel and Isla on the left and the Bran, Almond and Earn on the right. During the upper part of its course the Tay flows with a rapid current through a wild and highly romantic country and subsequently, after entering Strathmore, through the richest and finest valley in Scotland. In the summer of 1878 a railway bridge spanning the estuary of the Tay at Dundee was opened for traffic, but on 28 Dec. 1879 13 spans, crossing the navigable part of the river, were blown down in a violent storm, a passenger train, which then happened to be crossing, being precipitated at the same time into the river. A second bridge, over two miles long, with 85 spans and carrying two lines of rail, was opened in 1887. (2) A loch in the county of Perth, a picturesque sheet of water 15 miles long and about one mile broad; receiving at its southwest end (near Killin) the Lochay and the Dochart and discharging at its northeast end at Kenmore by the Tay. It is 100 to 600 feet deep and is well supplied with fish. On its northwest shore rises Ben Lawers.

TAYABAS, tä-yä'bäs, Philippines, (1) Pueblo province of Tayabas; on Tayabas River, five miles inland, 65 miles southeast of Manila. Under Spanish jurisdiction it was the capital of the province, and is the largest town. It is an important road centre and carries on a large trade. Pop. 15,000. (2) Province, forming the western part of southern Luzon; bounded on the north by the Pacific Ocean, and Lamón Bay and Ambos Camarines, on the east by Ambos Camarines and the Visayan Sea, on the south by the Mindoro Sea, and on the west by Batangas and Laguna; area, about 5,000 square miles. The outline is very irregular; its extreme length from Point Piapi in the northwest to Point Pagsanján in the southeast is 102 miles; and the distance from the northeastern boundary to Sandoval Point on the southwest is 47 miles. Its coasts are indented by three of the largest bays of the Philippines, Lamón on the north, Ragay on the east and Tayabas on the south. The province is generally mountainous, the main central chain extends from northwest to southeast, and this range sends out spurs on each side. There are numerous small rivers and streams. The soil of the valleys is fertile; on the lower levels rice, sugar and coffee are raised and grain on the higher levels; a special product is a seed called lumbang from which an oil is made; the cocoanut is grown in large quantities. The forests contain a variety of woods for building purposes, besides gum and resin trees; and large quantities of timber and forest products are exported. The mechanical industries of this province are of considerable importance; the manufactures include hats, cigar cases and boxes and native fabrics; there are also mills for extracting cocoanut oil and a number of boat-building yards for the construction of native boats. Stock-raising is also of some importance. The province has good communication by water with all parts of the Philippines, and is traversed by the main highway from Sorsogón to Manila; there are also several other roads and trails. The inhabitants of the western part of the province are Tagalogs, those of the eastern part are Bícols. Civil government was established in March 1901, in accordance with the law of the Philippine Commission. Pop. about 150,000.

TAYGETUS, tā-ĭj'ĕ-tŭs, Greece, a mountain range running down the central peninsula of southern Morea. It is a steep and unbroken ridge rising in Hagios Elias to a height of 7,904 feet. It separated ancient Sparta from Messenia and was known in the Middle Ages as Pentedaktylon.

TAYLOR, tā'lôr, (James) Bayard, American writer: b. Kennett Square, Pa., 11 Jan. 1825; d. Berlin, Germany, 19 Dec. 1878. He had a secondary education at West Chester and Unionville, and in 1842 was apprenticed to a printer in the former town, but did not serve out his apprenticeship. In 1844 he set sail for Liverpool, and during the next two years he traveled, chiefly on foot, in Great Britain, Belgium, Germany, Austria, Italy and France. He described his journeys for several American newspapers, his letters being collected and published on his return under the title 'Views Afoot or Europe Seen with Knapsack and Staff' (1846). In 1847 he received an appointment on the staff of the New York *Tribune*, and two years later went to California as special correspondent of that newspaper at the gold-fields, his letters being republished in 1850 as 'Eldorado, or Adventures in the Path of Empire.' In 1851 he was again in Europe, and before returning to the United States in 1854 he visited Egypt, Asia Minor, India, Hongkong, China and Japan. Among the literary results of this tour were 'A Journey to Central Africa' (1854); 'The Land of the Saracen' (1854), and 'A Visit to India, China and Japan' (1855). On these traveling experiences he lectured with much success. He had by this time gained some reputation as a poet by 'Ximena and Other Poems' (1844); 'Rhymes of Travel, Ballads, and Other Poems' (1848); 'A Book of Romances, Lyrics and Songs' (1851), and 'Poems of the Orient' (1855); and in 1855 he published a collective edition of these under the title 'Poems of Home and Travel.' 'Northern Travel' (1857) contains an account of a visit to Sweden, Denmark and Lapland. In 1862–63 he was secretary of legation and for a time chargé-d'affaires at Saint Petersburg, and in 1870 he lectured at Cornell University on German literature. He became United States Ambassador at Berlin in May

1878. In addition to works already mentioned the following may be enumerated: 'At Home and Abroad' (1859–62); 'Byways and Europe' (1869); a translation of Goethe's 'Faust' in the original metres (1870); the novels; 'Hannah Thurston' (1863); 'John Godfrey's Fortunes' (1864); 'The Story of Kennett' (1886); 'Joseph and His Friend' (1870); 'The Poet's Journal' (1863), and other volumes of verse. Two collections of miscellaneous writings appeared posthumously, 'Studies in German Literature' (1879), and 'Essays and Notes' (1880). It is by his translation of 'Faust,' one of the finest attempts of the kind in any literature, that Taylor is generally known; yet as an original poet he stands well up in the second rank of Americans. His 'Poems of the Orient' and his Pennsylvania ballads comprise his best work. His verse is finished and sonorous, but at times over-rhetorical. Consult the 'Life and Letters' by his wife and H. E. Scudder (1884).

TAYLOR, Bert Leston, American author: b. Goshen, Mass., 13 Nov. 1866. His column headed 'A Line o'Type or Two' in the *Chicago Daily Tribune,* conducted humorously, attracts much popularity. He has written 'The Well in the Wood' (1904); 'The Charlatans' (1906); 'A Line-o'-Verse or Two' (1911); 'The Pipesmoke Carry' (1912); 'Motley Measures' (1913); also two booklets, 'The Bilioustine' and 'The Book Booster' (1901).

TAYLOR, Brook, English mathematician: b. Edmonton, 18 Aug. 1685; d. 29 Dec. 1731. He was educated at Saint John's College, Cambridge; in 1712 chosen a Fellow of the Royal Society, and in January 1714 appointed its secretary. The most important of Taylor's works, published in 1715, is entitled 'Methodus Incrementorum Directa et Inversa.' It contains, among other theorems of less consequence, a celebrated one, which is hence called 'Taylor's Theorem,' the importance of which was first recognized by Lagrange, who proposed to make it the foundation of the differential calculus. His other works include two treatises on linear perspective, besides contributions to the 'Philosophical Transactions.'

TAYLOR, Charles Fayette, American surgeon: b. Williston, Vt., 25 April 1827; d. Los Angeles, Cal., 25 Jan. 1899. He was educated in the public schools and was graduated (1856) at the University of Vermont. He next settled in New York studying the new 'Swedish movement' system which he learned from Dr. Roth in London. His specialization became treatment of the deformed and crippled in which he achieved a great reputation and founded the New York Orthopedic Dispensary. He invented the Taylor splint for spinal diseases, also the long extension hip splint. Among his works are 'The Theory and Practice of the Movement Cure,' 'Mechanical Treatment of Hip Joint Disease,' etc.

TAYLOR, Charles Henry, American journalist: b. Boston, 14 July 1846. He made his start in life as a printer and reporter and was private secretary to the governor of Massachusetts for three years. He served during the Civil War with the 38th Massachusetts Regiment and was lieutenant-colonel on the staff of Governor Claflin. He was member of the legislature in 1872, and in 1873 became manager and editor of the Boston *Daily Globe.* He built up the property and made it one of the most influential journals of New England.

TAYLOR, Charles Jay, American artist: b. New York, 11 Aug. 1855. Attended College City of New York, afterward graduated at Law School, Columbia University (1874), LL.B., subsequently studied art, National Academy Design, Art Students League and in London and Paris. Has illustrated many books, contributed drawings to prominent periodicals and exhibited at the National Academy of Design, Pennsylvania Academy Fine Arts, World's Fair, Chicago; Exposition Universelle, Paris; Pan-American, Buffalo, where awarded medal; Carnegie Institute, Pittsburgh, and at Panama-Pacific Exposition, San Francisco. He served on advisory committee on Fine Arts for the Panama-Pacific, representing Pennsylvania; also was one of the International Jury of Awards, Section of Fine Arts, for the same exposition. From 1911, professor of fine arts, Carnegie Institute of Technology, Pittsburgh.

TAYLOR, David Watson, American naval constructor: b. Louisa County, Va., 4 March, 1864. He was graduated at the United States Naval Academy in 1885, with the highest record ever made there. At Greenwich, England, in 1885, he received the highest honors of the Royal College, repeating the record in 1888. He was made captain, United States navy, in 1901 and, by 1917, was promoted to rear-admiral. In 1914 he became chief constructor of the United States navy and chief of the Bureau of Construction and Repair.

TAYLOR, Edward Thompson, American Methodist missionary: b. Richmond, Va., December 1793; d. Boston, Mass., 6 April 1871. At the age of seven he ran away to sea, and followed the sea until the age of 17. During the War of 1812 he was captured on a privateer of war, the *Black Hawk,* and was taken to England, being confined in Dartmoor prison. Being converted, he acted as chaplain in the prison and after his release, for a time was a tin and iron peddler, then a buyer of rags and a farmer. In 1819 he became a Methodist minister, and in 1828 was appointed missionary to the Seamen's Bethel in Boston, where he served for many years, attaining a wide reputation. Here he was called "Father Taylor" and was greatly loved by the sailors. In his sermons, which he delivered in the common language of his day, he made free use of nautical terms, and possessed a genial wit. In 1832 he visited Europe, and delivered many addresses. In 1842 he visited Palestine, and was chosen chaplain of the United States frigate *Macedonia,* when it sailed with relief in 1846, for famine stricken Ireland. Consult 'Father Taylor the Sailor Preacher' (1872).

TAYLOR, Sir Frederick Williams, Canadian financier: b. Moncton, New Brunswick, 1863. He entered the Bank of Montreal in 1878, becoming successively assistant inspector at head office (1897), joint manager at Chicago (1903), manager of London branch (1906), and general manager at Montreal (1913). He carried through huge banking loans to Canada during his London services.

He is a director of the Allen Line Steamship Company, Ltd., vice-president of the Canadian Bankers' Association, etc. For valuable services he was knighted in 1913.

TAYLOR, Frederick Winslow, American efficiency engineer: b. Germantown, Phila., 20 March 1856; d. 21 March 1915. Educated at Phillips Exeter Academy, but left on account of eyesight trouble, and was graduated (1883) at Stevens Institute of Technology. In 1878 he entered service at the Midvale Steel Company, Philadelphia, becoming, successively gang-boss, assistant foreman, foreman of machine shop, master mechanic, chief draughtsman and (1889) chief engineer. In the latter year he commenced his notable career of efficiency expert reorganizing manufacturing plants (shop accounting and sales departments) of which the Bethlehem Steel Company, Cramps' Shipbuilding Company, etc., were examples. He was the inventor of the Taylor-White process of treating modern high-speed tools, receiving a personal gold medal at Paris Exposition, 1900. Patents granted to him number over 100. He was president of the American Society of Mechanical Engineers, 1905–06. He wrote 'Concrete, Plain and Reinforced' (1905), in collaboration with S. E. Thompson; 'Art of Cutting Metals' (1905); 'Principles of Scientific Management' (1911); 'Shop Management' (1911), and contributed numerous articles on his special topic to *Proceedings of American Society of Mechanical Engineers.*

TAYLOR, George, American statesman, one of the signers of the Declaration of Independence: b. Ireland, 1716; d. Easton, Pa., 23 Feb. 1781. Disliking the medical profession, for which he was destined, he came to America as a «redemptioner,» and on arriving bound himself for a term of years to an iron manufacturer at Durham, Pa. His education and intelligence being discovered, his employer made him his clerk, and after his death Taylor married his widow and became master of the establishment. He was a member of the provincial assembly in 1764–70, when he was a judge of the County Court and colonel of militia. In October 1775 he was again elected to the provincial assembly and was active in the promotion of revolutionary measures. The action of some of the members of the Continental Congress the next year in refusing assent to the Declaration of Independence, led to the election of new members, 20 July 1776, of whom Taylor was one. He signed the Declaration on 2 August; subsequently negotiated a treaty with several of the Indian tribes on behalf of the United States, and in March 1777 retired from Congress to private life.

TAYLOR, Graham, American sociologist: b. Schenectady, N. Y., 2 May 1851. He was graduated (1870) at Rutgers College and at the Reformed Theological Seminary, New Brunswick, N. J., in 1873. He was ordained for the Dutch Reformed ministry in 1873, becoming pastor at Hopewell, N. Y. From 1880–92 he filled the pulpit of the Fourth Congregational Church, Hartford, Conn. He acted as professor of practical theology at Hartford Theological Seminary from 1888–92, and, since 1892, has served as professor of social economics at the Chicago Theological Seminary. He was founder of the Chicago Commons Social Settlement and has been resident warden since 1894. He is president of the Chicago School of Civics and Philanthropy and associate editor of *The Survey.* He has written 'Religion in Social Action' (1913), besides numerous editorial contributions to the *Chicago Daily News,* etc.

TAYLOR, Hannis, American diplomat: b. Newberne, N. C., 12 Sept. 1851. He was educated at the University of North Carolina and was Minister to Spain, 1893–97. From 1892 he was professor of constitutional and international law at Columbia; special counsel for the United States government before the Spanish Treaty Claims Commission in 1902, and counsel for the United States before the Alaskan Boundary Commission in 1903. He published 'The Origin and Growth of the English Constitution'; 'International Public Law' (1902); 'Jurisdiction and Procedure of the Supreme Court of the United States: The Science of Jurisprudence' (1908); 'The Origin and Growth of the American Constitution' (1916); 'Cicero — A Sketch of His Life and Works' (1916); 'Due Process of Law' (1916).

TAYLOR, Sir **Henry,** English poet and essayist: b. Bishop-Middleham, Durham, 18 Oct. 1800; d. Bournemouth, 27 March 1886. At 14 he entered the navy as midshipman, but returned after a few months. In 1817–20 he held a small appointment in London. Returning to his father's country home, he gave himself to serious study, and in 1822 wrote an article on Moore that was published in the *Quarterly Review.* He went to London, and in 1824 received a clerkship in the Colonial Office, with which he retained his connection for 48 years. He mingled with the intellectual life of the city, contributed to the *Quarterly Review* and wrote his first tragedy, 'Isaac Comnenus,' in 1827. He was favorably reviewed by Southey, but failed to attract popular notice. From 1828 to 1834 he was engaged upon another poetic drama, 'Philip van Artevelde,' his principal achievement in literature. It was formed upon Elizabethan models, and its style is marked by dignity and refinement. His other works include 'The Statesman' (1836), containing prose commentaries on official life and the conduct of business; 'Edwin the Fair' (1842), a historical drama; 'The Eve of the Conquest and other Poems' (1847); 'Notes from Life' (1847); 'The Virgin Widow,' a comedy afterward called 'A Sicilian Summer' (1850), and 'Saint Clement's Eve' (1862), a romantic drama. His autobiography was published in 1885. Consult his 'Works' (1878), and 'Correspondence,' edited by Dowden (1888).

TAYLOR, Henry Ling, American surgeon: b. New York, 17 March 1857. He was graduated (1877) at Sheffield Scientific School and obtained his diploma at the College of Physicians and Surgeons (Columbia) in 1881. Like his father, Charles Fayette Taylor (q.v.), he specializes on orthopedic branches and was professor of orthopedic surgery (1902–17) at Post-Graduate Medical School and Hospital, New York. He is consulting orthopedic surgeon at Mountainside Hospital, Montclair, N. J., and associate surgeon at the Hospital for Ruptured and Crippled. He was president American Orthopedic Association in 1908. He has written 'Orthopedic Surgery for Practitioners' (1900).

TAYLOR, Henry Osborn, American author: b. New York, 5 Dec. 1856. He was graduated from Harvard in 1878, received the degree of LL.B. at Columbia in 1881 and that of Litt.D. at Harvard in 1912. He has published 'Treatise on the Law of Private Corporations' (5th ed., 1902); 'Ancient Ideals: A Study of Intellectual and Spiritual Growth from Early Times to the Establishment of Christianity' (2 vols., 2d ed., 1913); 'The Classical Heritage of the Middle Ages' (3d ed., 1912); 'The Mediæval Mind' (2 vols., 2d ed., 1914); 'Deliverance — The Freeing of the Spirit in the Ancient World' (1915). Mr. Taylor is a member of the National Institute of Arts and Letters.

TAYLOR, Isaac (known as TAYLOR OF ONGAR), English Congregational clergyman and author: b. London, 1759; d. Ongar, Essex, 11 Dec. 1829. He was originally an engraver, but entered the ministry and was pastor at Colchester, 1796–1810 and at Ongar, Essex, 1811–29. He published many works, chiefly books for the young, among which are 'Advice to the Teens'; 'Beginnings of British Biography'; 'Beginnings of European Biography'; 'Biography of a Brown Loaf'; 'Book of Martyrs for the Young'; 'Bunyan Explained to a Child'; 'Child's Life of Christ'; 'Mirabilia; or, The Wonders of Nature and Art'; 'Scenes in America, in Asia, in Europe, in Foreign Lands.'

TAYLOR, Isaac, English writer, son of the preceding: b. Levenham, Suffolk, 17 Aug. 1787; d. Stanford Rivers, 28 June 1865. His life was almost entirely passed in retirement at the place where he died, and is only remarkable for the literary work which he produced. His first book is entitled 'Elements of Thought' (1823). It was succeeded by numerous others, most of which are of a partly philosophical, partly religious cast. The principal are 'The Natural History of Enthusiasm' (1829); 'The Natural History of Fanaticism' (1833); 'Spiritual Despotism' (1835); 'Physical Theory of Another Life' (1836); 'Ancient Christianity' (1839–43); 'Loyola and Jesuitism' (1849); 'Wesley and Methodism' (1851); 'Restoration of Belief' (1855); 'World of Mind' (1857); 'Ultimate Civilization' (1860), and 'Spirit of Hebrew Poetry' (1861). The first of these works is that by which his name is chiefly known, although originally published anonymously. The work on ancient Christianity was composed with the view of correcting the errors which the author believed many were likely to fall into in consequence of the appeals of the writers of the Oxford tracts to the authority and practice of the early Church.

TAYLOR, Isaac, English scholar, son of the author of 'The Natural History of Enthusiasm': b. Stanford Rivers, Essex, 2 May 1829; d. Settrington, Yorkshire, 18 Oct. 1901. He was graduated from Trinity College, Cambridge, and in the following year issued a translation of Bekker's 'Charicles.' He was ordained in 1857, and in 1860 published 'The Liturgy and the Dissenters.' In the latter year he became a curate in London, and in 1864 published the first of the works by which he is chiefly remembered, 'Words and Places, or Etymological Illustrations of History, Ethnology and Geography.' In 1865–69 he held a curacy in a Bethnal Green parish, and his arduous labors there are described in 'The Burden of the Poor.' He became vicar of Holy Trinity, Twickenham, in 1869, and in 1875 was presented to the rectory of Settrington, near Malton, in Yorkshire, which he retained until his death. In 1879 he first propounded the theory of the Greek origin of runes in a work entitled 'Greeks and Goths: A Study on the Runes'; and he published in German a treatise 'Ueber den ursprung des glagolitischen Alphabets,' but his *magnum opus*, 'The Alphabet: an Account of the Origin and Development of Letters,' did not appear until 1883. In 1885 he was appointed canon of York. His other works include 'The Family Pen: Memorials, Biographical and Literary, of the Taylors of Ongar' (1867); 'Etruscan Researches' (1874); 'Leaves from an Egyptian Note-Book' (1888); 'The Origin of the Aryans' (1889); and 'Names and their Histories: A Handbook of Historical Geography and Topographical Nomenclature' (1896).

TAYLOR, Isaac Ebenezer, American physician: b. Philadelphia, 25 April 1812; d. New York, 30 Oct. 1889. He was graduated from Rutgers College in 1830, and in medicine from the University of Pennsylvania in 1834. He subsequently studied in Europe, settled in New York, and had charge of the department of women's diseases at the City, Eastern, Northern and Demitt dispensaries for seven years each. In 1851 he was elected physician to Bellevue Hospital, where he initiated important reforms, secured the foundation of the hospital college, and became its head, 1861. He was subsequently president of the medical board of the hospital; attending physician and head of the medical board of the Charity Hospital, and obstetrical physician to the Maternity Hospital. He was the first American to introduce uterine auscultation, helped introduce the hypodermic method of treatment by morphia and strychnia, and was the earliest in this country to use the speculum in diseases of women and children. He published a monograph on this subject in 1841.

TAYLOR, James Knox, American architect: b. Knoxville, Ill., 11 Oct. 1857. He took a special course (1877–79) in architecture at the Massachusetts Institute of Technology, then served in New York architects' office three and a half years. From 1882–92 he practised at Saint Paul and at Philadelphia from 1892–1905. In 1895 he was appointed senior draughtsman at the United States architect's office and then, till 1897, principal draughtsman. From 1897–1912 he was supervising architect and since 1912 has been director of architecture at the Massachusetts Institute of Technology, Boston.

TAYLOR, James Munroe, American educator: b. Brooklyn, N. Y., 5 Aug. 1848. He was graduated from the University of Rochester in 1868 and was pastor of a Baptist church in South Norwalk, Conn., 1873–82, and at Providence, R. I., 1882–86. From 1886 to February 1914 he was professor of ethics and president of Vassar College. He has published 'Psychology' (1893); 'New World and Old Gospel' (1900); 'Practical or Ideal' (1901); 'Before

Vassar Opened' (1914); 'Vassar: A History' (1915).

TAYLOR, Jane, English poet and author, daughter of Isaac Taylor, 1759–1829 (q.v.): b. London, 23 Sept. 1783; d. Ongar, Essex, 12 April 1823. She was educated under the supervision of her father and early displayed literary ability. Her work, which was very successful, bears some similarity in thought to that of Cowper. Her first work was 'The Beggar Boy' (1804) and in conjunction with her sister Ann (Mrs. Gilbert, of Nottingham, 1783–1824), she published 'Original Poems' and 'Hymns for Infant Minds.' Her other work includes 'Display,' a didactic tale (1815); 'Essays in Rhymes' (1816), and (published posthumously) 'Contributions of Q. Q. to a Periodical' (1826); 'Correspondence' (1825), etc. Consult Taylor, Isaac, 'Memorials of the Taylor Family' (1867).

TAYLOR, Jeremy, English prelate and author: b. Cambridge, 1613; d. Lisburn, County Antrim, Ireland, 13 Aug. 1667. After graduation in 1630 from Caius College, Cambridge, he was ordained in 1634, attracted some attention by his divinity lectures at Saint Paul's and was sent by Laud to Oxford, where he was admitted perpetual Fellow in 1636. He was presented to the rectory of Uppingham, Rutland, in 1638, to that of Overstone, Northamptonshire, in 1643. By this time he had made much of a reputation by his casuistical discourses. In the civil war he was committed to the Royalist party. As chaplain in ordinary to the king, he accompanied the army and was taken prisoner by the Parlimentarians in the battle before Cardigan Castle (1645). Soon released, he remained in Wales, having found, as he later said, that the «great storm» had «dashed the vessel of the church all in pieces.» While chaplain to Richard Vaughan, Earl of Carbery, at Golden Grove, Carmarthenshire, he did some of his best literary work, including 'The Liberty of Prophesying' (1646); 'Holy Living' (1650), and 'Holy Dying' (1651). He was twice imprisoned at Chepstow, occasionally preached to small Episcopalian congregations in London and in 1658 was appointed to a weekly lectureship at Lisburn, County Antrim. In April 1660 he signed the «declaration» of the Loyalists and in August following the Restoration was made bishop of Down and Connor. He found the diocese a troublesome one, owing to difficulties with the Presbyterian leaders, who refused to recognize Episcopal jurisdiction. At his first visitation he declared 36 churches vacant, their incumbents not having been episcopally ordained. Contrary to his purpose, he contributed greatly toward the establishment of Loyalist Presbyterians in northern Ireland as an independent ecclesiastical organization. Of his works, the best known is probably the 'Liberty of Prophesying' — by which he meant expounding — a defense of toleration. He rests this plea for private judgment on the uncertainty and inadequacy of tradition, the fallibility of any arbiter that may be selected on points of controversy, and the difficulty of expounding the Scriptures. Coleridge thought the result of the argument was that «so much can be said for every opinion and sect» that appeal must be made to «some positive jurisdiction on earth.» Perhaps Taylor's was merely a «legal settlement.» At any rate, it is otherwise inconsistent with his procedure in Ireland. But he was at his best not as an accurate theologian or polemic but as a preacher of righteousness. His literary genius is generally thought to be seen to best advantage in his sermons. They do not lack rhetorical faults — redundancy, diffuseness, a burdensome extent of quotation and illustration; but they are always eloquent, with a certain vividness, dignity and solidity for which many critics have been unable to find an equal in English prose. His devotional works, inspiring for their deep piety, are also highly valued for their usefulness. Next to the 'Liberty of Prophesying' they are most famous among Taylor's writings and now the most widely read. There are collected editions by Bishop Heber (1820–22) and by Eden (1847–54). (See HOLY LIVING; HOLY DYING). Consult Coleridge's 'Literary Remains'; Hunt, 'Religious Thought in England' (1870); Tulloch, 'Rational Theology' (1872); Barry, 'Classic Preachers' (1878); Dowden, 'Puritan and Anglican' (1901); 'Life' by Heber (1822), revised by Eden (1854); Gosse, 'Jeremy Taylor' (1904).

TAYLOR, John, English poet: b. Gloucestershire, 24 Aug. 1580; d. London, 25 July 1653. When young he was taken to London and apprenticed to a waterman, hence the title of «water-poet,» by which he is commonly known. He was at the taking of Cadiz, under the Earl of Essex, in 1596, and afterward visited Germany and Scotland. At home he was many years collector for the lieutenant of the Tower of London and his fees of the wines from all the ships which brought them up the Thames. When the civil war broke out he retired to Oxford, where he kept a common victualing house, and wrote pasquinades upon the Roundheads. He afterward kept a public house at Westminster. Certain of his works are published under the title 'All the Works of John Taylor, the Water-Poet, being Sixty and Three in Number, collected into one volume by the author, with sundry new Additions, corrected, revised, and newly imprinted' (1630). His pieces were subsequently increased to more than double that number. They are not destitute of natural humor and of the jingling wit which prevailed so much during the reign of James I. As a mirror of the coarse manners of his times they are invaluable to the historian and antiquary.

TAYLOR, John, Mormon president: b. Milnthorp, Westmoreland County, England, 1 Nov. 1808; d. Salt Lake City, Utah, 25 July 1887. He was born of parents professing the faith of the Church of England, but while a youth became a Methodist local preacher. In 1832 he emigrated to Canada and in 1835 was converted to the Mormon faith during the missionary tour of Porley P. Pratt. He was ordained a high priest by Joseph Smith in 1837 and in 1840 went as a Mormon missionary to various parts of the British Isles. The following year he returned and settled at Nauvoo, Ill., where in 1844, in company with several other Mormon leaders, charges of sedition and disloyalty were brought against him. The Carthage jail where the prisoners were confined was attacked by a mob, two of his companions were killed and he was severely wounded. Returning from a second mission to England in 1846 he went to the new Mormon settlement in Salt Lake City and in 1849 was elected an associate judge of the Mormon State of Deseret. He subsequently translated and published the 'Book of Mormon' in French and German. In 1854 he was elected a member of the legislative council and the next year began a mission in New York, published *The Mormon* and took charge of Mormon followers in the East. From 1877 to 1880 he was president of the Twelve Apostles and in the latter year organized the first presidency of the Church anew and took the chief place himself. In March 1885 he was among those indicted by a Federal grand jury under the Edmunds Law; but remained in concealment until his death.

TAYLOR, John Louis, American jurist: b. London, England, 1 March 1769; d. Raleigh, N. C., 29 Jan. 1829. Arriving in this country in his 12th year he gained an education at William and Mary College, Virginia, and was admitted to the bar after reading law without tuition. He settled at Fayetteville and became member of the legislature (1792–95). Moving to Newbern (1796) he was appointed (1798) judge of the Superior Court, a position he held for 20 years, being chief justice 10 years of the time. In 1818 he was elected as the first chief justice of the Supreme Court of North Carolina. He was appointed (1817), jointly with Judge Henry Potter, to revise the statute laws of the State, which caused publication of the work 'Potter's Revisal' (1821), which work he continued and published (1825), known as 'Taylor's Revisal.' He also wrote 'Treatise on Executors and Administrators' (1825).

TAYLOR, Mary Imlay, American novelist: b. Washington, D. C. She has published 'An Imperial Lover'; 'A Yankee Volunteer' (1898); 'The Cardinal's Musketeer' (1900); 'The Cobbler of Nîmes' (1900); 'Anne Scarlett' (1901); 'Little Mistress Good Hope' (1902); 'The Rebellion of the Princes' (1903); 'On the Red Staircase' (1906); 'The Impersonator' (1906); 'My Lady Clancarty' (1907); 'The Reaping' (1908); 'Caleb French' (1910); 'The Long Way' (1913). She is also the author of the photoplays, 'The Ploughshare'; 'Friend Wilson'; 'Daughter,' etc.

TAYLOR, Nathaniel William, American Congregational clergyman: b. New Milford, Conn., 23 June 1786; d. New Haven, Conn., 10 March 1858. He was graduated at Yale in 1807 and five years later became the pastor of the First Congregational Church at New Haven, in which position he continued until 1822, when he resigned to become professor of theology at Yale. This chair he held during the remainder of his life. He maintained the "New Haven theology," and especially on the doctrine of total depravity, which was regarded as heretical, led him into a controversy with the less liberal branch of the Congregational church in 1828–30. His works were edited and published by Noah Porter (1858–59).

TAYLOR, Philip Meadows, English military officer and author: b. Liverpool, 25 Sept. 1808; d. Mentone, France, 13 May 1876. He entered the Nizam's army in India in 1824 and in 1841 was made administrator of the state of Shorapore, subduing its rebellious ruler. He rendered valuable service in keeping order during the berar mutiny in 1857, for which he was promoted to the rank of colonel. He published 'Confessions of a Thug' (1839); 'Tara' (1863); 'Ralph Darnell' (1865); 'Manual of the History of India' (1870); 'A Noble Queen' (1878), and other works. His autobiography was published in 1877.

TAYLOR, Richard, American soldier, son of Zachary Taylor (q.v.): b. New Orleans, La., 27 Jan. 1826; d. New York, 12 April 1879. He was graduated from Yale in 1845, after which he went to his father's camp on the Rio Grande and was present at Palo Alto and Resaca de la Palma. He sat in the Louisiana senate in 1856–60 and was a member of the Louisiana Secession Convention. He aided in the organization of the Confederate troops, commanded a brigade under "Stonewall" Jackson and fought at Front Royal, Middletown, Winchester, Strasburg, Cross Keys, Port Republic and also in the seven days' battle before Richmond. He was then promoted major-general and assigned to the command of Louisiana, where he succeeded in strengthening the Confederate position, an advantage which was lost by the fall of Vicksburg in 1863. On 8 April 1864 he met and defeated General Banks at Sabine Cross-Roads, but on the following day lost his advantage and was in his turn defeated. He was promoted lieutenant-general in 1864 and placed in command of the Department of Alabama and Mississippi. After the surrender of Lee and Johnston he capitulated to General Canby at Citronelle, 8 May 1865. He published 'Destruction and Reconstruction' (1879).

TAYLOR, Robert William, American physician: b. London, England, 11 Aug. 1842; d. 1908. He was graduated at the College of Physicians and Surgeons, New York (1868) and started practice in that city. He was professor of diseases of the skin at Woman's Medical College, New York, and in the medical department of the University of Vermont; also surgeon in the venereal department of Charity Hospital, Bellevue Hospital Dispensary, New York Dispensary, etc. He wrote 'A Practical Treatise on Sexual Disorders of the Male and Female' (New York, 3d ed., 1905).

TAYLOR, Rowland, English martyr: b. Rothbury, Northumberland; d. Hadleigh, Suffolk, 9 Feb. 1555. He was graduated at Cambridge University and appointed by Cranmer, to whom he was domestic chaplain, rector of Hadleigh and he became archdeacon of Exeter and a canon of Rochester. Under Mary he was imprisoned, as a heretic, for more than a 12-month and on being condemned to the stake suffered at Hadleigh. Consult Cooper, 'Athenæ Cantabrigienses' (1858).

TAYLOR, Thomas, English scholar: b. London, 15 May 1758; d. Walworth, 1 Nov. 1835. He was educated (with the idea of becoming a Dissenting minister) at Saint Paul's School, London, but entered a banking house as clerk, and subsequently served for several years as assistant secretary to the Society for the Encouragement of Arts, Manufactures and Commerce. On the condition of his devoting himself to literary work for the last 40 years of his life he received during that period a pension of $500 a year from his friend, W. Meredith, who also defrayed the expenses of publishing his translation of 'Aristotle' in 10 volumes (1806-12). His edition of 'Plato' in English (1804) was published at the expense of the Duke of Norfolk, who locked up nearly the whole edition in his own house, where it remained until 1848 when it was sold by auction. Taylor's works comprise about 60 volumes and include treatises on arithmetic and geometry and translations of Proclus and Plotinus. Opinions differ as to the exactness of his scholarship, but he well deserved his title of «Platonist» and did good service to British philosophy and literature by introducing to the public as completely as possible the masters of Greek thought in an English garb.

TAYLOR, Sir Thomas Wardlaw, Canadian jurist: b. Auchtermuchty, Fifeshire, Scotland, 25 March 1833. He was educated at Edinburgh University, removed to Canada and in 1858 was admitted to the bar of Upper Canada. He was master in chancery, 1872-83 and puisne judge of Queen's Bench of Manitoba, 1883-87. From 1887 to 1899 he was chief justice of Manitoba and administrator of the government of that province in 1890 and 1893. His specialty is equity jurisprudence and he has published 'Commentaries on Equity Jurisprudence' (1875); 'Chancery Statutes and Orders'; 'Public Statutes Relating to the Presbyterian Church.'

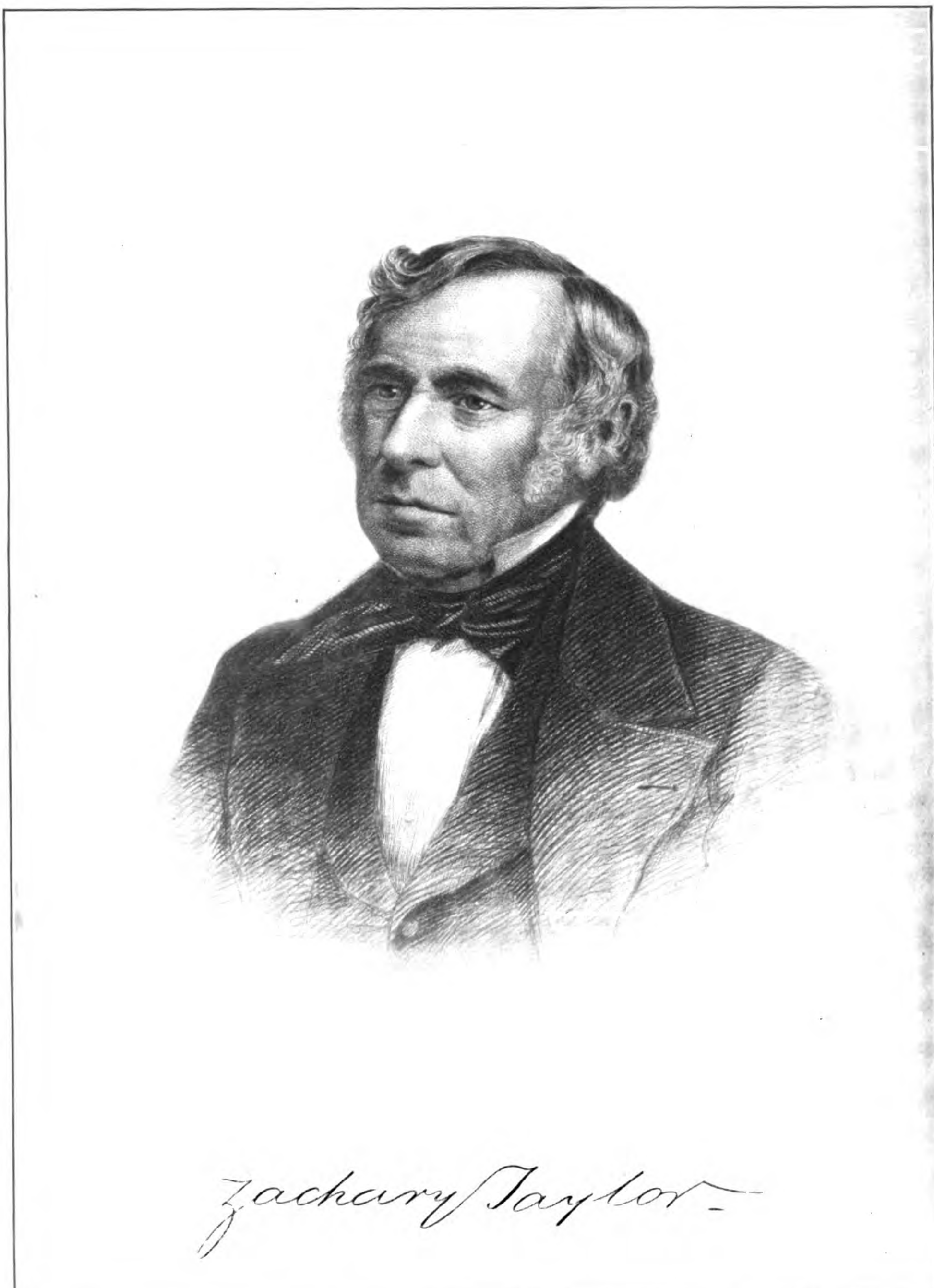
TAYLOR, Tom, English dramatist and journalist: b. Bishop-Wearmouth (Sunderland), 19 Oct. 1817; d. Wandsworth, 12 July 1880. He was educated at the University of Glasgow and at Trinity College, Cambridge, graduating from the latter in 1840. He was elected a Fellow of his college in 1842 and in 1845-47 he was professor of the English language and literature in University College, London. Called to the bar in 1846, he was on the northern circuit for a time, but in 1850 was appointed assistant secretary, in 1854 secretary to the board of health. On the formation of the local government board he was made secretary of the sanitary department and when his post was abolished in 1871 he retired with a pension. He engaged in journalistic work at an early stage in his career and in 1844 began his connection with *Punch,* which continued until his death; in 1874 he succeeded Shirley Brooks as editor. He was the author of a large number of successful plays, including 'To Parents and Guardians' (1845); 'Masks and Faces' (1852), in collaboration with Charles Reade, 'To Oblige Benson' (1854), an adaptation from the French; 'Our American Cousin' (1858), first produced at Laura Keane's theatre, New York, when Sothern created the character of Lord Dundreary; 'New Men and Old Acres' (1859), partly by A. W. Dubourg; 'The Overland Route' (1860); 'The Ticket-of-Leave Man' (1863), based upon a French work; 'The Fool's Revenge' (1869), based upon Hugo's 'Le Roi S'Amuse'; 'Twixt Axe and Crown' (1870), adapted from the German; 'Joan of Arc' (1871); 'Lady Clancarty' (1874), and 'Settling Day' (1877). He wrote a striking poem on the death of Lincoln eulogizing the martyr and atoning for the past critical offenses of *Punch.*

TAYLOR, William, American Methodist bishop: b. Rockbridge County, Va., 2 May 1821; d. Palo Alto, Cal., 18 May 1902. He became a Methodist preacher in 1842, served as an itinerant until 1849 and was then sent as missionary to California. He was engaged in that field until 1856 after which he spent five years in Canada and in the eastern States. In 1862 he went out as an evangelist and continued his work for many years in Australia, Asia, Africa and South America. He was particularly successful in his work among the Kaffirs in South Africa, where he established numerous independent mission churches and in 1884 was elected missionary bishop for Africa. He is said to have visited in the course of his missionary work every English-speaking country in the world. After his elevation to the office of bishop he went to Central Africa where he established a chain of 36 mission stations along the Kongo. He published 'Seven Years Preaching in San Francisco' (1856); 'Infancy and Manhood of Christian Life' (1867); 'The Story of My Life' (1882); 'Pauline Methods of Missionary Work' (1889), etc.

TAYLOR, William Ladd, American artist and illustrator: b. Grafton, Mass., 10 Dec. 1854. He was educated at Worcester, Mass., and studied art at Boston and New York schools and under the tuition of Boulanger and Lefebvre, Paris, from 1884-85. Since that time he has been painter and illustrator. Some of his best works are Selections from Longfellow's poems; a series of illustrations depicting 19th century New England, his 'Pioneer West' series, 'Psalms' series, pictures from the Old Testament, etc.

TAYLOR, William Mackergo, American Congregational clergyman: b. Kilmarnock, Scotland, 23 Oct. 1829; d. 8 Feb. 1895. He was graduated at the University of Glasgow and studied theology at Divinity Hall of the United Presbyterian Church, Edinburgh, till 1852. He then was ordained and became pastor at Kilmaurs till his fame called him (1855) to a new congregation at Bootle, Liverpool, where he preached till 1871, obtaining a great and growing congregation. In the latter year he accepted the invitation to fill the pulpit of the Rev. Dr. Storrs, Brooklyn, for a vacation season, which caused his call to the Broadway Tabernacle Church, New York, where he gained great popularity. He wrote much for the *Scottish Review* and over 30 of his works were published. He was for four years editor-in-chief of *Christian at Work.* Yale and Amherst (1872) conferred the degree of D.D. and (1883) the College of New Jersey gave him its LL.D. diploma.

TAYLOR, Zachary, 12th President of the United States: b. Orange County, Va., 24 Sept. 1784; d. 9 July 1850. His father, Col. Richard Taylor, served under Washington and he held a number of important offices in Kentucky where he migrated soon after the birth of Zachary. Young Taylor grew up in the vicinity of Louisville in the midst of its exciting frontier life. In 1808 aroused by the Chesapeake outrage, Taylor asked for a commission in the army and in May was commissioned first


Zachary Taylor

lieutenant in the Seventh United States infantry. In 1812 he was made a captain and in the War of 1812 gained distinction in defeating an Indian attack on Fort Harrison, for which success he was breveted a major. In May 1814 he received a regular commission as major but left the service at the close of the war on being reduced to the rank of captain. He re-entered the army in 1816 and in 1819 was promoted to a lieutenant-colonelcy. For the next few years he was stationed at different frontier posts but in 1832 during the Black Hawk War, as colonel, received the surrender of the Indian chieftain. In 1832 he was ordered to Florida in the Seminole campaign and at the battle of Okeechobee (25 Dec. 1837) won a decisive victory over the Indians, for which he was breveted a brigadier-general. Taylor spent the next four years in Florida and was then given command of the First Department of the army with headquarters at Fort Jessup, La. On 28 May 1845 Taylor, in command of the army of the Southwest, was ordered to hold himself in readiness to defend Texas from a possible invasion should the latter State accept the terms of annexation. On 30 July 1845 he was ordered to «occupy, protect and defend Texas,» and to approach the Rio Grande which was «claimed to be the boundary between the two countries» (Texas and Mexico). At the same time he was cautioned to keep away from the Mexican settlements and posts. In August, Taylor selected a position at Corpus Christi on the Nueces. Then followed a series of ambiguous orders from the War Department commanding him to check any Mexican army endeavoring to cross the Rio Grande or any *attempt* to do so. Taylor reported there was no concentration of Mexicans on the Rio Grande nor any signs of war; but, beginning to understand what the administration desired of him, asked for definite orders to advance. This the War Department refused to give and for a few months a delay ensued while the administration renewed its negotiations with the Mexican government. At last, in obedience to instructions from Washington, on 11 March 1846 Taylor began his advance from Corpus Christi to the Rio Grande. On the 28th he arrived opposite the Mexican town of Matamoras and began the construction of Fort Texas, afterward called Fort Brown, upon the present site of Brownsville. Taylor blocked the mouth of the Rio Grande with a view of cutting off all supplies from Matamoras and thus forcing the Mexican troops stationed there either to withdraw or to assume the offensive. On 12 April General Ampudia summoned him to retire beyond the Nueces, and with Taylor's refusal to do so the first conflict occurred on 24 April when a party of dragoons were ambushed by the Mexicans. President Polk at once sent a message to Congress recommending a declaration of war, asserting that «Mexico has passed the boundary of the United States, has invaded our territory and shed American blood upon the American soil.»

The war on Mexico began with the advance of Taylor's forces. On 8 and 9 May, Taylor defeated the Mexicans at the battle of Palo Alto and Resaca de la Palma and forced them to cross the Rio Grande. Following in quick pursuit, Taylor occupied Matamoras (18 May). With the refusal of Mexico to negotiate, Polk determined to conquer the northern provinces and in August, Taylor resumed his advance and after a three days' battle captured the city of Monterey (21–23 September). By this time Polk began to distrust Taylor on account of his supposed Whig affiliations. It was embarrassing for a Democratic administration to have a Whig general reaping all the glory, and with a view toward checking his operations Polk detached most of Taylor's experienced troops for the intended advance upon Vera Cruz under Gen. Winfield Scott. Santa Anna, the Mexican commander-in-chief, learning of Taylor's weakened condition rapidly concentrated 20,000 men and marched northward to crush him. To retire to the Rio Grande meant a loss of all the prestige so far gained and, therefore, Taylor decided to fight. He took a position at the hacienda Buena Vista, five miles south of Saltillo. Here after three unsuccessful attempts by Santa Anna, Taylor gained the most decisive victory of the whole war and remained in undisputed possession of the region. Taylor's brilliant victory, handicapped as he had been by the authorities in Washington, suggested him as a possible Presidential candidate to the Whig politicians. Thurlow Weed learned from the «general's brother that Taylor had always been an admirer of Clay and preferred home-made goods to foreign importations.» Taylor meetings became the fashion throughout the country; he was nominated at public assemblies in Ohio, Kentucky, Virginia, Pennsylvania and elsewhere, and although he had never even voted and had no views on political topics, supported by Weed, Crittenden and Stephens, he gained the nomination at the Whig Convention (May 1848) over the claims of Webster and Clay. In the succeeding campaign Taylor carried eight slave States while his opponent secured seven. The one all-absorbing question after the inauguration of Taylor was the question of what should be done with slavery in the Territories. Both parties in the campaign had side-stepped the issue, the Whigs having adopted no platform and the Democrats having trusted to the well-known views of their candidate, Lewis Cass. President Taylor, although master of a plantation in Louisiana, admitted anti-slavery leaders in the Whig party to his counsel and William H. Seward became his confidential adviser. The Wilmot proviso, the question of the organization of the Territory of Oregon and the admission of California already had demanded immediate attention. Accordingly the first message of the President was awaited with interest. Taylor already had made up his mind to recommend the admission of California as a free State and his fatherly message breathed with devotion to the Union. But Clay and Webster determined to take matters into their own hands and in January Clay offered his plan of compromising the sectional issue. Taylor characterized the Territorial portion of Clay's measures as the «Omnibus Bill» and was preparing to oppose them when he died on 9 July 1850.

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R. C. McGrane.

TAYLOR, Pa., town in Lackawanna County, on the Central Railroad of New Jersey and the Delaware and Lackawanna Railroad. It is situated three miles southwest of Scranton, its chief industries being coal-mining and silk-mills. Pop. in 1900 was 4,215 and in 1915, 11,591.

TAYLOR, Tex., town in Williamson County, on the Missouri, Kanasas and Texas and the International and Great Northern railroads, about 30 miles northeast of Austin, the capital of the State. It is in an agricultural and stockraising section. The chief manufacturing establishments are cottonseed-oil mills, cotton-compresses, railroad shops, flour and planing mills. There are about 75 manufactories, with an annual output of over $500,000. There are good banking facilities and newspapers. There are large shipments of grain, vegetables, cotton products, fruit and livestock. Pop. 5,314.

TAYLOR INSTITUTION, Oxford England, connected with the university, is designed mainly for the promotion of the study of modern European languages. It owes its foundation to a bequest of Sir Robert Taylor. The building belonging to it was erected in 1848. The institution comprises four teacherships of modern European languages and a library, and there are in connection with it a scholarship and an exhibition. It is under the management of nine curators, all of whom must be members of convocation. The library is open free to all members of the university, and other literary persons may be admitted by special permission. The curators of the institution have also the administration of a fund bequeathed by William Thomas Horner for the encouragement of the study of the Polish and other Slavonic languages.

TAYLOR UNIVERSITY, located at Upland, Ind. The forerunner of the university was the Fort Wayne Female College, organized in 1846 at Fort Wayne, Ind. In 1852 this college united with the Collegiate Institution at the same place, and became a coeducational school. The name was changed to Taylor University in 1890. In 1893 a new charter was obtained, and the university moved to its present site, the citizens of Upland donating 10 acres of ground and $10,000. It is under the control of the National Association of Local Preachers of the Methodist Episcopal Church. It was named for Bishop Taylor, the first Methodist missionary bishop to Africa, who had a part in its organization. The departments of the university are the college of liberal arts, the academy, commissioned by the State as a high school, the Reade theological seminary, the school of music, the school of expression, the normal department and the commercial department. The college offers two courses, classical and scientific, leading respectively to the degrees of A.B. and B.S. A part of the work of each course is elective. The theological school offers two courses; the English Bible and the seminary course, leading to the degree of B.D. A very strong school of music accredited by the State Teachers' Training Board has a separate building. The course in expression requires four years. The commercial department offers two courses: bookkeeping and stenography. The spirit of the college is markedly religious, a number of graduates every year become missionaries; and the students' religious organizations are strong. The library contains 7,000 volumes. The students average annually 340 and the faculty 19.

TAYLORVILLE, Ill., city, county-seat of Christian County, on the South Fork of the Sangamon River, and on the Wabash and the Baltimore and Ohio Southwestern railroads, about 24 miles southeast of Springfield and 27 miles southwest of Decatur. It is in an agricultural and coal-mining region, and has considerable manufacturing interests. There is an iron foundry, paper mill and manufactories of wagons, agricultural implements, chemicals, brick and tile. The chief shipments are coal, hay, livestock and manufactures. There are eight churches, a high school, graded schools and a public library. There are three banks, one national with a capital of $80,000, and two private banks. Pop. about 5,446.

TAYRA, tī-rą, a brown, elongated, weasel-like fur-bearer (*Galictis barbera*) of Mexico and South America, which sometimes gathers in large bands. It has a long bushy tail.

TAYTAY, tī-tī', Philippines, (1) pueblo, province of Paragua, island of Palawan, on the northeast coast on Taytay Bay. It is the chief town of the province and is protected by a fort mounting several guns and capable of accommodating a garrison of 700. Agriculture and fishing are the chief industries. Pop. (estimated) 7,420. (2) Pueblo, province of Rizal, Luzon, 10 miles east of Manila. Pop. 6,800.

TAYUG, tä-yoog', Philippines, pueblo, province of Pangasinan, Luzon, in the extreme northeast of the province, near the Agno River, 34 miles east of Lingayen. It is on the highway from San Quintin to Aseñgan. Pop. 19,612.

TCHAD, chăd, or **CHAD,** Africa, a large lake in the Sudan, situated at the common junction of Kamerun, British Nigeria and French Sahara, lat. 13° N., long. 14° E. It lies about 750 feet above sea-level. Its area during the rainy season is about 30,000 square miles, but in the dry season it shrinks to less than 7,000 square miles, and is then surrounded by vast marshes, while the remaining water is very shallow. The water is drinkable, although the lake has no apparent outlet; it appears to be gradually drying up and liable eventually to be a desert. Rarely is more than 20 feet of water to be encountered, and the marshy areas increase in size.

TCHAIKOVSKY, chī-kŏf'skē, **Peter, Ilich,** the greatest of Russian composers: b. Votinsk, government of Viatka, 7 May (not 25 Dec.) 1840; d. Saint Petersburgh, 6 Nov. 1893, of cholera. His father, a mining engineer, had no intention of making a musician of him, but had him educated at the Technological Institute in Saint Petersburg, after leaving which he obtained a post in the Ministry of Justice. But Peter was a gifted amateur, whose playing in social circles was much appreciated. In 1861 he wrote to his sister: "I told you I was studying the theory of music with considerable success. It is generally agreed that with my uncommon talents (I hope you will not take this for mere boasting) it would be a pity not to try my luck in this career." Shortly thereafter he entered the Conservatory, where he soon attracted the attention of Anton Rubinstein, who relates that once he gave the young man a theme and asked him to write a set of variations on it. He expected about a dozen, but Tchaikovsky brought him over 200! From Rubinstein he also took lessons in orchestration; the instruments on which he practised were the piano and the organ; also the flute, of which he afterward made such admirable use in his 'Nutcracker Suite' and other works. His talent was ere long generally appreciated; in 1865 Laroche, afterward an eminent critic, referred to him as "the future star of Russian music"; this led to his being sent to Moscow in 1866 to teach the theory of music at the newly opened Conservatory. Although he disliked giving lessons, he proved a conscientious and useful teacher. Thenceforth he devoted most of his spare time to composing; but although he had "an almost feminine craving for approval and encouragement," his experiences were little more than a series of disappointments. His wordly prospects nevertheless steadily improved and in 1877 he married, to the surprise of his friends. The hasty marriage had a tragic sequel. The union was not a happy one, and the pair soon separated. The composer was so despondent that he attempted to commit suicide in such a way as to avoid scandal by standing up to his chest in the icy river one night, in the hope of catching a deadly cold. In the following year another woman influenced his life, in a happier way. He did not know her, and she preferred to keep her identity concealed, but she put aside for his benefit a sum of money which made it possible for him to give up his Conservatory classes and save his energy for his creative work. Many master-works now came from his pen. He had never cared for society and detested city life, so his friends were not surprised when, in 1885, he took a house near the village of Klin, where he was isolated as completely from the world as was Wagner when he wrote his 'Meistersinger' score in his villa near Lucerne. He became known as "the Hermit of Klin," and refused to see any one but friends and such musicians as he chose now and then to invite for a party. By constitution he was strong, wiry and not easily fatigued; he was fond of outdoor exercise and many of his musical ideas came to him on his walks. He aged much as he neared his 50's; his scant hair grew white and his face lined. In May 1891 he visited America and gave concerts in New York and other cities. Two years later he conducted some of his works at Oxford and received the degree of doctor of music from the university. In the autumn of 1893 the world was startled by the news of his death. He succumbed to an attack of cholera, after a short illness. There were rumors of his having committed suicide, but his friend and biographer Kashkin discountenances them.

The suicide rumors were strengthened by the character of his last symphony, which is now known throughout the world as the 'Pathetic,' the most lugubrious of all symphonic works. A more heart-rending wail of grief than its adagio lamentoso has never been heard; and as this slow movement, contrary to all precedent, closes the symphony, it seemed like an intentional farewell to the world. "This music," says Huneker, "is a page torn from Ecclesiastes; it is the cosmos in crape." Schubert once said that the world liked best those of his songs which were born of sorrow. It was the doleful sixth symphony that made Tchaikovsky famous. Seldom has a work so great and deep won so instantaneous a success — a success so remarkable as to unduly overshadow his other five symphonies except, to some extent, the fifth, which resembles the sixth in mood and music. Like Beethoven, Tchaikovsky is greatest in his orchestral works, which include, beside the six symphonies, seven symphonic poems: 'The Tempest'; 'Francesca da Rimini'; 'Manfred'; 'Romeo and Juliet'; 'Hamlet'; 'Fatum'; 'Le Voyevode.' In these, which contain some of his best and most mature music, he manifests his sympathy with Liszt and modern program music. Among his other orchestral works the three that have become most famous are the '1812' overture, the 'Marche Slave' and the 'Nutcracker Suite,' which contains the best musical numbers of one of his three ballets. His 11 operas are much less modern in spirit and structure than his symphonic works and the only one of them that has attracted much attention outside of Russia is the fourth, 'Eugene Onegin.' It has been said of his operas that "just as the gracious beauty of Italian melody seemed doomed to pass away under a new dispensation, it was reincarnated in the works of this northern composer." There is much beautiful melody also in some of his 100 lyric songs; the best-known of them are the 'Spanish Serenade,' 'None but a Lonely Heart,' 'Why so Pale are the Roses.' Not a few of the songs are pot-boilers and the same is true of many of his pianoforte pieces, the best of which, however, deserve to be better known. Pianists neglect them because of their awkward technique. Three pianoforte concertos, a violin concerto, a string sextet and other pieces of chamber music must be added to the list of his compositions. His work as a whole is characterized by a remarkable variety; now it is classical, even old-fashioned, now ultra-modern; now Russian, now cosmopolitan. German critics have described his symphonies as rough, patchy, barbarous, nihilistic; but music lovers the world over are showing a keener insight and are learning to love this Russian music as they learned to love the Polish music of Chopin, the Hungarian of Liszt, the Norwegian of Greig. The authoritative life of Tchaikovsky has been written by his brother Modest. A shorter volume (in English) by Rosa Newmarch, includes extracts from his critical writings and diaries. Consult also Kashkin, 'Reminiscences'; Huneker, 'Mezzotints in Modern Music'; Riemann, 'Geschichte der Musik seit Beethoven.' A 'Catalogue Thematique' of the compositions is issued by Jurgenson, Moscow.

Henry T. Finck,
Musical Editor New York 'Evening Post.'

TCHEKHOV, Anton P. See Chekhoff; Cherry Orchard, The; and Sea Gull, The.

TCHIKUN, an American Indian tribe of the Apache (q.v.) family, formerly residing at Hot Springs, N. Mex.

TE DEUM LAUDAMUS, tē dē'ūm lâ-dā'-mŭs, or more abbreviated, **TE DEUM**, is the beginning of the hymn of praise usually ascribed to Saint Ambrose and Saint Augustine, although it cannot be traced farther back than the end of the 5th century, while Saint Augustine died in 430. The opening words, meaning, «We praise thee as God,» show that it was originally a hymn to Christ, but it is now always regarded as a hymn to the Father, the English version beginning, «We praise thee, O God.» In addition to its place in church services it is often sung on particular occasions, as on the news of victories and on high festival days. Among the great composers of music for this hymn are Hasse, Naumann, Haydn and Handel.

TEA, an evergreen shrub or small tree (*Camellia thea*) of the order (*Ternstrœmiaceæ*). The plant naturally attains a height of 30 feet, but under cultivation is pruned so that it rarely exceeds five feet. It bears lanceolate leaves about four inches long and rather large fragrant white flowers singly or in twos or threes, mostly in the axils of the leaves. It is a native of India and China, and has been cultivated in the latter country more than 2,000 years. Of several recognized species, only two have become commercially valuable: *C. thea*, var. *Bohea*, and *C. thea*, var. *viridis*. The latter is indigenous to India, the former recognized as a hybrid of Chinese species, probably with the original India variety.

Cultivation.— The ground on which a plantation of tea is to be set out is dug over in trenches to the depth of at least 18 inches, and 24 inches is preferred if the expense — about double — is not deterrent. As the plantation is of a permanent character, intended for a productive period of probably 30 years, every effort is made to have the soil in the best of condition, and well manured. The plants are taken from a nursery where they have been grown from seed for from six to 12 months, and set four feet apart both ways for «hill» culture. Where the ground is especially favorable they are set five feet apart. On poor soil the «hedge» system is practised, the plants being three feet apart in the hedge, and the hedges five feet apart. The plant has a tap-root descending eight to 10 feet into the earth. From this the feeding roots ramify in all directions. The cultivation consists in keeping the ground loose and free from weeds by surface hoeing, and once a year trenching the soil — from 18 inches in depth between the rows to nine inches next the «collar» of the plants. This is done in the late autumn, just after pruning, and the prunings along with green manure, preferably from leguminous plants, are spaded under. These prunings are estimated to restore to the soil 95 pounds of combined nitrogen, 56 pounds of potash and 19.6 pounds of phosphoric acid per acre. The pruning is done while the plant is passive, usually in December. On the hill plantations pruning is done annually: on level gardens, every other year or every third year — the practice being to prune alternately one-half or one-third of the plantation. The unpruned trees furnish the smaller leaves and, therefore, the higher grade tea, and their flushes come earlier, thus extending the picking season. On new plantations pruning begins when the trees are 12 to 18 months old, at which time the centre stem is cut down to within nine inches or even six inches above the ground — the object being to produce a growth of many branches and twigs, and thus a larger bulk of leafage which may be plucked without injury to the plant. The second pruning takes off everything to a level of 18 inches above the ground. As much of the tea is picked by children, the height of the plants in such localities is restricted to 30 inches. A very small plucking is made the second year, and the third year the yield is about 150 pounds per acre. The full yield of about 400 pounds per acre begins with the fifth year. The plant continues to yield well until its 10th year, when it is cut down and new sprouts developed from the trunk. This process is repeated until the plantation is 30 years old, when it is removed and new plants set out.

Plucking.— Plucking is an operation necessarily done by hand, and requires judgment as to the amount of leafage that may be removed at one picking without halting the normal growth of the plant. The plucking follows the «flush,» that is, the springing into leafage of the terminal buds after the winter rest. The second flush in the season is the leafing out of the top axillary buds on the stumps of the terminal bud-stems removed at the first picking. The succeeding flushes are not well marked, but there are generally 10 and sometimes 15 in the course of the growing season. In a well-ordered plantation the trees are plucked over about 30 times during the season, with the intent of getting the leaves while in their very best condition. The bud produces the finest quality of finished tea; the partly opened leaf next below it, being slightly less valuable, and the next leaves below distinctly coarser. The usual practice is to pluck the bud with the two adjacent open leaves. Plantations which produce only the highest grade of tea pluck the bud and one leaf. Many growers, however, pluck the bud and the first three leaves. The first few crops are thus very large, but the endurance of the plantation is seriously affected, and the net profits very decidedly reduced. The quality, however, does not depend wholly upon the plucking: much depends upon the soil and the climate. The average yield is about two and one-half ounces of finished tea per plant per season.

Processing.— The handling of the tea leaves after plucking is determined by the kind of finished tea to be produced. In the case of black tea the leaves are wilted or withered on trays in a draught of dry cool air often produced by fans. This is continued until the leaf is soft and flaccid. The average time required for withering is 18 hours: less than that does not allow sufficient development of the peculiar enzyme required for the subsequent fermentation upon which the flavor of the finished tea so largely depends. Withering is followed by rolling on tables of granite, the motion of the rollers being to crush the cells of the leaf without breaking its structure. In this process of rolling the leaves incidentally receive the characteristic twist noticeable in finished tea. The time occupied in rolling is from 20 to 40 minutes. The leaves are then run through a sifter which grades them into sizes, and then are spread upon glass or glazed-tile tables to ferment. During this process they are covered with cloths freshly wrung out of cold water. The time required for proper fermentation depends upon the previous development of the ferment during withering, and may take from two to six hours. The temperature is kept scrupulously to 85° F., or slightly below, and the time of completion is determined by the odor, which at first resembles chopped cabbage, but becomes fruity, resembling that of fine ripe apples. Lightly fermented tea yields when finished a pale, pungent infusion, the pungence due to an excess of unfermented tannin. Fully fermented tea yields a deep-colored, soft-flavored liquor of good body. The best tea is that which receives a medium fermentation and has in consequence a brisk taste, with high flavor and aroma. The final step in the process is drying the leaves rapidly to check further fermentation. The trays go first to a position near the furnace where the temperature is 260° and thence travel away from the source of heat, finishing where the heat is at 100°. In many factories a second firing is given after a few days, and this is considered to enhance the ultimate quality of the tea as it comes into the market after overseas transportation.

Before packing the finished tea is sorted over by hand, and vagrant bits of stalks and red leaves are removed. It is then sifted into grades. In the ordinary factory these are five: Broken Orange Pekoe, Orange Pekoe, Pekoe, Pekoe Souchong and Pekoe Fannings. The first is composed almost wholly of terminal buds and broken portions of the youngest and tenderest first leaves; the second is of the smallest leaves and a few buds; the third and fourth grades are of the coarser leaves, and the Souchong is usually chopped up to show a smaller range of size in the market. The Fannings are the finer fragments and dust, used chiefly in the manufacture of caffeine, or of «brick tea.»

Green Tea.— In the manufacture of green tea the freshly plucked leaves are thrown directly into a roasting pan at a temperature of 250° and are kept tossing about until flaccid, when they are emptied upon a mat of bamboo and rolled by hand. They are then dried quickly over a charcoal fire. The older leaves are deficient in proper color and are treated with small quantities of Prussian blue, indigo or soapstone. The former teas are called «natural green,» or «unfinished green,» in contrast with the doctored leaves, which go under the title of «true green» or «finished green.»

Oolong tea is prepared by a combination of the two methods, being slightly withered and lightly fermented and then treated as for green tea.

Brick Tea is a condensed preparation of the coarser leaves and even the prunings of the plantation. These are panned and steamed, and then placed in piles under cloth covers. A peculiar ferment resembling a black fungus spreads through the mass, which is then sorted, mixed with a glutinous rice paste, lightly steamed and then pressed into molds four feet long, nine and one-fourth inches wide and four and one-fourth inches deep. Three «bricks» are made in this depth, containing when dry four and one-half pounds each. Another form of brick tea is made into tablet form, four and one-half inches square and one and one-fourth inches thick and weighing half a pound each.

Tea Culture in the United States.— In the United States the first tea shrub was planted at Middleton Barony, S. C., in 1800 by the French botanist Micheaux. It was still living at the close of the 19th century, when it was about 15 feet high. In 1848 experiments were made upon an extensive scale by Junius Smith of Greenville, S. C., and in 1858 the government engaged Robert Fortune to collect tea seed for distribution in the South. These experiments were cut short, the former by the death of the experimenter, the latter by the Civil War. About 1880, the United States Department of Agriculture commenced experiments which were abandoned owing to various changes in the staff and the distance from the managing headquarters. About 10 years later Dr. Charles U. Shepard of Summerville, S. C., devoted his private means to tea experimentation. His opinion was that the previous experiments had not been conclusive and that the production of high grade teas at a profit to the grower could be accomplished in many Southern States and that a demonstration would attract capital to the industry. Once demonstrated as profitable he believed that the industry would furnish employment to many thousands of people, especially women and children, and would make valuable large areas of land which yielded little or nothing. In 1900 he had about 60 acres planted to this crop, a factory fully equipped, a trained band of pickers and facilities for meeting every requisite from planting to final sale. In 1900 the yield was about 5,000 pounds and when the present area reaches full bearing the annual output should be more than 12,000 pounds.

The tea plant, though a native of a subtropical climate, will succeed at high elevations in tropical countries and some of the numerous varieties will even withstand frost. In South Carolina the plants have resisted a temperature of zero, but the yield was lessened for the next two years. This is the lowest recorded temperature in that locality during 150 years. Ample water, especially during the leaf-forming season, is essential. This is supplied in the East by copious rains, but in the United States, where the rainfall is less than one-half the Eastern annual average, the deficiency is made up by improved methods of tillage or by artificial irrigation or both. In the East the tea gardens are generally planted on high ground or slopes so as to permit the excess water to seep away; in America they are planted on rather low ground such as well-drained pond-beds and swamps. Such lands are also naturally rich as a rule and, therefore, demand less initial application of fertilizers.

History.— The history of the tea-growing industry is said to have commenced in Korea before the 4th century before Christ, and to have reached Japan more than 1,000 years later. Tea was unknown to Europeans until the 16th century when Maffel, a Portuguese, mentions it in his 'Historiæ Indicæ' as a product of Japan and China. Not until 1615, however, was it mentioned by an Englishman, when Wickman wrote about it in a letter now owned by the East India Company. During that century small quantities found their way as presents to wealthy Londoners or later into the markets where they commanded £10 or £5 a pound. In 1657 a considerable quantity was purchased by Thomas Garraway, who opened a sort of restaurant where the beverage was served. As the importations increased, the customs and the excise each affixed duties. At one time (1660–89) a duty of 8d a gallon was levied upon the beverage. And somewhat later 5s. plus an ad valorem duty of 5 per cent was also operative. The American tea trade began in 1784 and within three years had developed to more than 1,000,000 pounds. The first direct importation from Japan came from Yokohama to San Francisco in 1868. Since 1870 the annual average importation is somewhat in excess of $15,000,000.

From the beginning of the commerce in tea, China has held first place as a producing and exporting country. The choicest grades, however, are probably unknown in America, but are consumed mostly at home or in Russia, where they command enormous prices. The reasons assigned for the non-exportation to distant countries are that the quality usually deteriorates during long transportation, and that some kinds do not keep well unless highly "fired," a process which impairs their flavor. The industry attracted the attention of the English in India and in 1836 Royle and Falooner, British botanists, commenced in Ceylon to experiment upon an extensive scale. The result was several brands of tea which were superior to many of the Chinese teas. Ceylon began to market tea in 1873 and the industry there has continued to thrive. Tea has been grown more or less in other sub-tropical and tropical climates, notably in South Africa, where somewhat more than a domestic supply is raised.

The large number of plants whose leaves have been used as substitutes for tea may be grouped as resembling or not resembling the real plant in composition. The best known of the former are as follows: Maté, Paraguay tea, Jesuits' or Saint Bartholomew's tea, which is obtained from the leaves of a South American species of holly (*Ilex paraguayensis*). This is extensively used in various South American countries, especially in the Argentine Republic, where the annual consumption is estimated at 13 pounds per capita, or about 27,000,000 pounds. Kola nut, coffee leaves and guarana are also used, but to a smaller extent. The principal substitutes unlike tea are probably Siberian tea (*Saxifraga crassifolia*), Chilean tea (*Eugenia ugni*), Appalachian tea (*Prinos glabra*), Trinidad tea (*Eugenia pimenta*), Labrador tea (*Ledum buxifolium*), and New Jersey tea (*Ceanothus americanus*). The last was used during the War of Independence and also during the War of the Rebellion. It is described as "a good substitute for indifferent black tea." The leaves of the partridge berry (*Mitchella repens*) are sometimes used in America.

In conservatories and greenhouses tea is often grown as ornamental plants and as objects of interest. The plants are managed like their close relatives, the camellias, but are less popular because more limited in their uses, especially because their flowers are axillary and hence less useful for cutting than those of the camellias.

Production.— The world's annual production of finished tea amounts to something over 800,000,000 pounds. The World War so affected production and shipment of the crop that it is necessary to take the figures of production for 1912, as being the latest complete record under normal conditions, to form an accurate idea of the tea-growing industry. In that year the areas devoted to tea were as follows: China, 5,120,000 acres (approximately); India, 575,000 acres, of which 354,276 acres were in Assam; Ceylon, about 395,000 acres; Java, nearly 100,000 acres; Japan, about 100,000 acres; South Africa (Natal and Nyassaland) about 4,600 acres. The crops sold in the world's markets from these producing countries amounted to a grand total of 731,000,000 pounds, contributed thus: India, 295,000,000 pounds; Ceylon, 193,000,000 pounds; China, 112,000,000 pounds; Java, 63,000,000 pounds; Japan, 43,000,000 pounds; Formosa, 25,000,000 pounds.

Consumption.— The chief purchasing countries of the 1912 crop were: United Kingdom, 295,000,000 pounds; Russia, 147,000,000 pounds; United States, 83,000,000 pounds; Canada, 34,000,000 pounds; Australia, 29,000,000 pounds; Holland, 12,000,000 pounds; Germany, 9,000,000 pounds; New Zealand, 7,000,000 pounds; South Africa, 7,000,000 pounds. In per capita consumption the British Empire as a whole was in remarkable degree the largest consumer, the average being 6.2 pounds, about 10 times the per capita consumption of all the rest of the world put together (excluding the United States). For the individual countries the per capita consumption figures were: New Zealand, 7.4 pounds; Australia, 6.8 pounds; United Kingdom, 6.4 pounds; Canada, 4.3 pounds; Holland, 2.1 pounds; South Africa, 1.2 pounds; United States, 0.9 pound; Russia, 0.9 pound; Germany, 0.1 pound; France, 0.07 pound.

Infusion.—As found in the market tea yields from 31 to 49 per cent of its substance to an infusion with boiling water, the Indian teas giving slightly more than the Ceylon teas, and the China teas slightly less. In this water extract the tannin constituent ranges from 14.33 per cent in India teas and 12.29 per cent in Ceylon teas to 9.50 per cent in China teas. (With thorough fermentation the proportion of tanning would fall below 5 per cent). Caffeine varies from 2.78 to 3.84 per cent in India teas, and ranges up to 4.14 per cent in Ceylon tea and 4.91 per cent in tea dust. In making the infusion for beverage purposes the finest flavored tea is produced by pouring fresh and actively boiling water upon the dry leaves and allowing it to stand not longer than one and one-half minutes, when the infusion should be immediately poured off the grounds. This brief infusion is sufficiently long to absorb practically all of the delicate essential oil which gives the tea its particular flavor. It is also long enough to dissolve out sufficient of the tannic acid to make the taste sprightly, without being astringent. The infusion will also contain about four-fifths of the contained caffeine. The strong, biting quality preferred by some tea drinkers is gained by a five-minute infusion, which dissolves a large proportion of tannin, but at the expense of the volatile oil of the tea which is dissipated by the continued heat. In moderate quantities tea as a beverage is not considered harmful, the average dose of caffeine being mildly stimulating, and the tannin, owing to its transformation to gallic acid in the intestinal tract, being innocuous. There is also a valuable proportion of albuminoid extractives in the infusion, and the water imbibed is a necessity to the continued health of the system.

Imports.— The imports of tea into the United States for the fiscal year ended 30 June 1918 reached the record figure of 151,314,932 pounds, despite the great difficulties of a scarce and expensive ocean tonnage. The value of the importation was $30,889,030. Of the whole, 52,996,474 pounds came from Japan; 44,540,467 pounds from India and Ceylon, and 21,082,866 pounds from China.

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M. G. KAINS,
Crop Expert.

TEA, Varieties of. Teas were named mostly after the place of origin, as Japanese tea, including all from that country, but more specifically a brownish-green leaf tea, well-twisted. The qualities are indicated as long-leaf, wiry or well-curled, light-colored, etc. Ceylon tea is named mostly after the large plantations there; the varieties are termed pekoes, pekoe souchongs, souchong, congou, broken leaf, etc.; the congou is black, the souchong a black inclining to red, the pekoe black with yellowish tips, while the red leaf is known as kaisow. The hyson is a large-leaved green tea; the hyson skin is the remnants discovered in putting up hyson. Oolong is a greenish yellow tea, and Twankay a green tea lightly or imperfectly rolled. Bohea is a standard black tea gathered three times a year from old plants. The variety largely advertised as "English breakfast" is souchong, while imperial is any good bluish-green tea, long leaf, tight-rolled. Imperfect teas are named in the trade as broken leaf, dust, ends, fannings, etc.

TEA IN AMERICA. About 1880 the United States Department of Agriculture established a small tea-growing plantation near Summerville, S. C., and various varieties were raised in an experimental way. Later the plan was extended and the Pinehurst Tea Gardens opened in the suburbs, being supplied with native tea grown on a tract of about 100 acres and manufactured and cured by competent people. Further experiments were made at a place christened Tea, in Colleton County, S. C., and at Pierce, Texas. While it was found possible to grow good teas and to cure them satisfactorily, it was apparently impossible to produce them in competition with the teas of China and Japan, cured by cheap Oriental labor. Hence the experiments were wholly negative commercially.

TEA-TREE, a name applied not only to the *Thea* bushes (see TEA), but to various species of *Leptospermum* and *Melaleuca* — myrtaceous shrubs found from China to Australia, New Zealand and Tasmania. The tea-tree forms a common and almost impenetrable scrub of Victoria, in moist situations. It is a shrub of varying height and dark-green color, the branches bushy and growing perpendicularly, the leaves resembling the needles of a fir. The stems are straight, the wood hard and valuable for many bush purposes. Several of the tea-trees belonging to the genus *Melaleuca* furnish the aromatic, pungent cajeput oil (see CAJEPUT) of commerce. It is especially obtained from *M. leucadendron,* a tree reaching 30 feet in height, with terminal spikes of white flowers, and elliptical to lanceolate leaves, from which the oil is distilled. It has a crooked trunk, papery bark, employed in packing, and yields a wood which is white, close-grained, hard and durable, even under the ground. *M. squarrosa* or swamp tea-tree has a thin bark, and the thin, spongy cortex of *M. axillaris* can be used as a filter or blotting paper. The New Zealand tea-tree or tea-scrub is *Leptospermum scoparium,* a heather or juniper-like shrub with leathery foliage, like needles, and many small white blossoms. The common name is said to have been derived from the use of the foliage of this shrub and that of *L. lanigerum* by Captain Cook for tea, but the native name of the former is "ti." The white tea-tree is *L. ericoides,* of New Zealand. Other tea-trees are the bottle-green *Kunzea corifolia,* and the broad-leaved *Callistemon salignus,* both of Australia and Tasmania; the Ceylon, *Elæodendron glaucum,* and the red scrub tea, *Rhodamnia trinervia,* several of which are myrtaceous and have hard, heavy close-grained wood.

TEACH, or THATCH, Edward ("BLACKBEARD THE PIRATE"), American pirate: b. Bristol (?), England; d. on the James River, Va., 22 Nov. 1718. He is supposed to have gone out to the West Indies during the war of the Spanish succession, engaged as a privateer, and to have turned pirate in 1713 when the privateers refused to recognize the peace. He is first heard of in 1716 and from that time he cruised among the West Indies, along the Spanish Main, and the coasts of Virginia and Carolina, in his sloop, *Queen Anne's Revenge,* capturing numerous prizes and making his name a terror wherever known. In June 1718, his sloop was wrecked off North Carolina, and Thatch, with some 30 of his men surrendered to the king's proclamation. He made an ally of the governor, Eden, who afterward countenanced his piracy in view of a certain share in the spoils, and for a time led a rollicking life, forcing the planters to supply his wants and exacting toll from all vessels which came up or down the river. The planters at length appealed to Col. Alexander Spottiswood, lieutenant-governor of Virginia, who fitted out an expedition against the pirate, and on 22 Nov. 1718 the sloops moved up the river. Every man in the commander's boat was killed, and the captain, Robert Maynard, slew Thatch in a hand-to-hand struggle. His career is one of the most romantic in the history of American piracy, «Blackbeard the Pirate» being considered the ideal type of the pirate of fiction. Consult his 'Life' in Charles Johnson's 'Lives of the Pyrates' (1724).

TEACHERS, Professional Training of. Richard Mulcaster of London advocated the professional training of teachers as early as 1561 and suggested that a teachers' college be organized as a department in a university. Nothing definite or permanent appears to have come from this suggestion. The first genuine effort for the professional training of teachers undertaken in the world was undoubtedly by Jean-Baptiste de La Salle at Rheims in 1681. Three years later the institution which he founded at Rheims became known as the «Institute of the Brothers of the Christian Schools.» He later established a similar school at Paris. In this school he organized a regular, systematic course of instruction for the preparation of teachers for their professional work. Augustus Hermann Francke conducted an orphans' school at Halle and in 1697 he selected certain poor students in attendance upon this school and organized them into a «teachers' class.» The members of this class gave instruction to the other pupils in the orphans' school, and for this service Francke allowed them free tuition and board. Twelve years later Francke selected 12 students from the pupils in his orphan asylum to be trained as teachers. These students were selected upon «their piety, knowledge, and aptness to teach.» Francke called this institution a «Teachers' Seminary.» Hecker — a pupil of Francke — has the honor of establishing the first regularly organized institution devoted to the special work of training teachers. This school was established at Pomerania, Prussia, in 1735 and Hecker gave to it the name used by Francke and called it a teachers' seminary. Hecker established a second school of this type at Berlin in 1748. Frederick the Great gave official endorsement to the effort to provide special training for those who were to be employed as teachers in the schools, by raising Hecker's school at Berlin to the rank of a royal primary school for the purpose of training parish clerks and teachers. He gave this school further royal favor by directing that all parish clerks and all teachers appointed by the Crown should be selected from its students. Little progress was made in the establishment of institutions of this kind or in the training of teachers in Europe until after the French Revolution. At the beginning of the 19th century, the development of institutions to train teachers took on new life and the Prussian system of normal schools was firmly established. Six normal schools had been organized in that country.

It was about this time that the subject of preparing teachers for public schools began to receive attention in America. Men interested in public education began to discuss the subject. The manner in which these men first treated the subject does not indicate that they were familiar with what had been done in Europe in the training of teachers or with the system of normal schools which Prussia had established. The papers prepared by these men reveal a consciousness of the necessity of establishing adequate educational facilities in America and of preparing teachers to take charge of such schools as should be established. The papers written by these men indicate that these writers were speaking from the experiences and needs of the nation and not from historical knowledge of what had taken place in other countries. Among the numerous articles which appeared at this time and which exerted great influence in developing the idea that teachers should be professionally trained were the address of Denison Olmstead in 1816 on the «State of Education in Connecticut,» the pamphlet issued in 1823 by William Russell, principal of the New Haven Academy, on the subject of «Suggestions on Education,» the publication entitled «Lectures on School-keeping» issued in 1829 by Samuel R. Hall who founded a school for training teachers at Concord, Vt., in 1823, the articles published by James G. Carter in the Boston *Patriot* in the winter of 1824–25, the paper of Rev. Thomas H. Gallaudet in 1825 on a «Plan of a Seminary for the Education of the Instructors of Youth,» the pamphlet of Walter R. Johnson of Germantown, Pa., issued in 1825, on «Observations of the Improvement of Seminaries of Learning in the United States, with suggestions for its Accomplishment,» and many others. These articles gave to the public much valuable literature on the subject of education in general as well as upon the importance of special training for those who were to teach. The democracy of the nation was developing and with this development came a demand for schools. In the beginning of the 19th century 15 States either established systems of schools or reorganized existing systems. New York provided for State supervision of her schools in 1812 and 11 other States soon followed in making similar provision. The expansion, enlargement and improvement of educational facilities has always been coupled with a demand for better teachers.

The type of teachers employed in the schools in many cases was a potent argument in behalf of a system of training teachers. The men employed as teachers in the academies and colleges were generally men of education and character. This was not true of the men employed in the elementary schools. Often these teachers possessed little education, had received, of course, no training and had no intention of remaining permanently in the teaching service. Men often sent their sons to Europe to be educated and sometimes imported teachers from Europe to instruct their sons. Men who were unable to get other employment because of their lack of education or of proper character often enlisted in the teaching ranks. But even in this demoralized situation, able young men who were either working their way through college or had completed their college courses and intended to enter either the professions of the law, medicine, or ministry, or business careers, taught a few terms or years. Among the many men of this type, the following may be mentioned: John Adams, Eli Whitney, Daniel Webster, William Ellery Channing, William H. Seward, Salmon P. Chase, and in later times James G. Blaine and Elihu Root. As late as 1837 Horace Mann stated that, of the teachers employed in the State of Massachusetts outside of the city of Boston, about 200 expected to devote themselves to teaching and that the others were not generally qualified and that some of them thought more of what they were to get at the end of the term than they did of what they were to give during the term. Leading men in public affairs in all parts of the country recognized this condition in educational matters and gave it consideration.

In 1794 the teachers of New York City formed an organization known as the "Society of Associated Teachers." The purpose of this society was to promote the interests of its members and of education generally. Members were elected to the society by ballot, and a three-fourths vote was necessary to an election. This society did much of the work now performed by the professional supervisory staff of a school system. It passed upon the qualifications of teachers, upon textbooks, upon the proper professional decorum of teachers and discussed the pedagogical questions of that early date. It had been a voluntary organization without legal status. Several of its members petitioned the legislature of the State for a charter incorporating the "Society of Teachers in New York City." The petition was honored and the original society of 1794 discontinued. The charter granted the organization stated, in the following language, the object of the society:

> "For the relief and benefit of decayed teachers and their families, widows and children of deceased teachers, and for the discussion of literary subjects and for the promotion of science among the members of the society."

The society immediately entered upon a program for the intellectual improvement of its members, and its official reports show that prior to 1815 and for several years subsequent thereto the society gave special work to train and equip young men for the teaching service in New York City. This society was undoubtedly the first agency in America which gave definite work to the training of teachers for public schools.

In 1805 through the initiative and influence of DeWitt Clinton, the legislature of New York incorporated "A Society for establishing a free school in the city of New York for the education of such poor children as do not belong to or are not provided for by any religious society." This society became known as the Free School Society of New York City. Its annual report for 1814 contains the following statement:

> "From the commencement of the society it has been an object of great interest to train up young men for the office of teachers in similar institutions. The realization of their wishes in this respect is in part accomplished."

Mr. Fitzpatrick in his work on DeWitt Clinton states that a youth educated in this school was superintending a similar school in New Brunswick, N. J., and that the society had received an application from Newburgh, N. Y., for a teacher. The Free School Society adopted the Lancasterian system of schools. The report of the Free School Society for 1819 gives an account of what the society was doing to train teachers and specifically states that those who desire to become teachers are invited to attend its school where they may be properly instructed in six or eight weeks to become competent teachers of the Lancasterian system. Here is a second organization endeavoring to train teachers for public schools. See article LANCASTERIAN SCHOOLS, Vol. 16, p. 687.

The official records do not indicate the precise year in which the academies in New York State first began to train teachers for the common schools. The academies did this work before legislation had been enacted authorizing the establishment of teachers' training classes. The report of the Regents to the legislature in 1821 contains the announcement that the academies were training teachers for the common schools and the Regents expressed the opinion that the schools of the State must look to the academies for their supply of teachers. In the annual report of the Regents for 1823 the statement is made that because of the distribution of public funds under its direction to the academies subject to its supervision, such action "insures a supply of competent teachers for the common schools." New York was undoubtedly the first State which took specific action to solve the problem of providing trained teachers for the common schools. One of the vital questions in the establishing of agencies for the training of teachers was bitterly contested in New York. This question was, Shall the established educational institutions be utilized for this purpose or shall separate institutions devoted solely to such work be organized? The academies in New York were numerous, influential and under the control of the Regents. The friends of these institutions were zealous in their efforts to have the academies designated to train teachers. The State was giving these institutions financial support from the literature fund. The academies began to give special training to those who were going out to teach as early at least as 1821 and such instruction has been given continuously since that date. The friends of the academies endeavored to increase the amount of State aid to these institutions and based their argument upon the service which the academies were rendering the State in training teachers. They were successful in 1827 and not only succeeded in obtaining larger financial support but also obtained statutory recognition to train teachers without specifying how such service should be performed. The Regents, however, at once designated certain academies for this purpose and other academies continued to do such work voluntarily. The academies still pressed their interests at the legislature and in 1834 obtained the enactment of a law specifically authorizing the Regents to designate academies in which training classes should be organized. These training classes have been continued since that time and 80 were maintained in the year 1918–19. Through this agency about 25,000 teachers have been supplied the rural schools of the State.

In 1823 Rev. Samuel Hall opened a school at Concord, Vt., for the training of teachers. He was sent to this town as a preacher by the Domestic Missionary Society of Vermont. He consented to remain upon the distinct understanding that he should be allowed to organize a school for the training of teachers. He admitted to his school a class of young pupils for the purpose of having the opportunity of showing those whom he was training the best methods of teaching and of disciplining and governing a school. The literature relative to this school shows that Mr. Hall had no textbooks, periodical or other helps or equipment, and that he conducted the school on his own knowledge and judgment of educational methods of procedure and his experience in teaching. Growing out of his experience in this school he gave a series of lectures on "school keeping." There was a great demand for this work and the supply was soon exhausted. The State of New York purchased 10,000 copies of this volume and put one in each of the school districts of the State.

While those who believed it was not necessary to establish separate institutions to train teachers and that adequate provision could be afforded for such work in existing institutions had won a victory in the State of New York, the question was not permanently settled. The training of teachers was being considered in a broad, comprehensive manner by thoughtful educators, by State supervisory school officers, by governors and by State legislatures. The strong presentation of the subject by Walter R. Johnson of Germantown, Pa., published in 1825 and of Rev. Thomas H. Gallaudet in the same year had made a deep impression upon those who were specifically interested in the solution of the problem. Dr. Philip Lindsley in his inaugural address as president of Cumberland College, Nashville, Tenn., in 1825, stated that the teacher needed training for his work as much as a lawyer or doctor and urged the establishment of teachers' seminaries and in 1826 he appeared before the legislature of that State and advocated the establishment of such seminaries. In the same year Gov. DeWitt Clinton in his message to the legislature of New York also advocated the establishment of a seminary for teachers. In 1826 State Superintendent Spencer in a special report to the senate of New York also urged the plan of teachers' seminaries. Governor Lincoln of Massachusetts in his messages of 1826 and 1827 to the legislature of that State urged the importance of making provision for the training of teachers. The American Institute of Instruction petitioned the legislature of Massachusetts upon the same subject in 1827. Dr. George Junkin, president of Lafayette College, and Rev. Chauncey Colton, president of Bristol College, in 1833 urged upon the legislature of Pennsylvania the establishment of courses in colleges for the training of teachers and that the common schools in the town should be used as practice departments. In December 1829, 57 citizens of Rochester, N. Y., called a public meeting in that city to consider the educational needs of the times. This committee prepared a report which was adopted by the meeting and among the recommendations was one for a State seminary to train teachers. A comprehensive plan was proposed for the administration of the seminary and for the course of study. This plan proposed "a farm of 100 to 200 acres, under the direction of an intelligent but *practical* farmer, a garden and a nursery under the direction of a practical gardener and nurseryman and a mechanics' shop with a general assortment of tools, such as the miscellaneous business of the farm and garden may require." In 1836 a public meeting of citizens in Philadelphia recommended the establishment of a teachers' seminary as an independent institution containing a three years' course of study and a model school. In the same year State Superintendent Burrowes of Pennsylvania recommended an appropriation of $10,000 for the establishment of two institutions — one in the eastern part of the State and the other in the western part, for the training of teachers. In 1829 the 'Annals of Education' edited by Woodbridge published a translation from a German periodical giving an account of the Prussian seminaries for the training of teachers. Articles on and translations of Cousin's 'Report on Public Instruction in Germany' appeared between 1830 and 1835. These were published extensively by the newspapers in all parts of the country. It was out of all these discussions and proposals that the normal school idea developed in America. There were two men in Massachusetts who rendered a vital service in the successful effort to establish a normal school. These men were Mr. Charles Brooks and Mr. James G. Carter. Mr. Brooks made a careful study of the Prussian system of normal schools and in a Thanksgiving sermon in 1835 at Hingham he explained that system. He prepared three lectures on the subject which he delivered in various parts of the State. He issued a circular inviting citizens of Plymouth County to meet him to consider the subject. This invitation included every board of selectmen, every school committee and every clergyman in the county. A large audience greeted him at the courthouse. The address so impressed Ichabod Morton that he offered to contribute $1,000 for the establishment of a normal school at Plymouth. Mr. Brooks traveled over 2,000 miles, delivering addresses in the State, and contributed a continuous series of articles on the subject to the newspapers. The house of representatives invited him to address that body, and, in January 1837, he addressed that house twice. He also addressed the legislatures of Vermont, New Hampshire, Maine and New Jersey, and many cities and villages in other States. Mr. Carter, who has often been called the "Father of Normal Schools," had given a comprehensive outline of his plan for training teachers in the articles which he wrote for the Boston *Patriot* in 1824–25. He specified three essential elements in the work of a normal school. These were: (1) the development of sound scholarship; (2) a course of study upon the science and art of education; (3) a model or practice school. Nearly a century later these three points are the vital features of the normal schools of America. The people of the town of Lancaster, Mass., offered to aid him in the establishment of a school in Lancaster, but later put obstacles in his way and the project failed. In 1835 Mr. Carter was elected to the legislature, and in 1836 he was made chairman of the committee on education. He urged the legislature to establish a seminary to train teachers, but failed in his efforts. He drew the bill providing for a State Board of Education, which became a law in 1837, and in 1838 his generalship and addresses brought about the enactment of the Normal School Law. Horace Mann, who was president of the Massachusetts senate, was chosen the first secretary of the State Board of Education in 1837. Mr. Mann was a strong advocate of the establishment of State normal schools. He obtained a promise from Edmund Dwight to provide $10,000 for the establishment of institutions to train teachers if the State would appropriate an additional $10,000. Mr. Mann communicated this proposition to the legislature 12 March 1838, and on 22 March a joint committee which had considered the subject reported a resolution appropriating $10,000 to the State Board of Education for the training of teachers, but conditioned on an additional $10,000 being paid to said board to aid in the enterprise. Governor Edward Everett gave executive approval to the resolution 19 April. The State Board was not restricted in the type of institution which it should establish. The action of the legislature gave that body the right to exercise its discretion. The State Board decided to establish three normal schools. The first of these institutions was opened at Lexington on 3 July 1839, with three pupils. The school was later removed to Framingham, and of course has the distinction of being the first normal school established in America. The second school was established at Barre in the same year, but was later removed to Westfield. Mr. Cyrus Pierce was the first principal of the Lexington school. The wisdom, the energy and the diplomacy of Horace Mann and of Principal Pierce made possible the success of this initial effort to establish a normal school in the United States. The third school was established at Bridgewater in 1840. The real battle ground for the establishment of normal schools was in Massachusetts and New York. Although those who favored the organization of training classes in New York had won a temporary victory, the campaign for a separate institution devoted solely to the training of teachers was continued in that State. The work accomplished in these training classes had not proved satisfactory. State Superintendent Spencer in 1840 appointed Dr. Alonzo Potter of Union College, later Bishop Potter of Philadelphia, and Hon. D. H. Little, a committee to examine these classes. The report of Dr. Potter was adverse to the training classes and recommended the establishment of a normal school. Superintendent Spencer had long been an advocate of training teachers in the academies and did not, therefore, agree with the report of Dr. Potter. Spencer was succeeded in office by Col. Samuel Young, a warm advocate of the normal school idea. Young was supported by Governor Seward and Governor Bouck. He made speeches throughout the State in favor of organizing a normal school and called a State meeting of deputy superintendents, similar to county superintendents, at Utica in 1842. This was a notable meeting. Gen. John A. Dix, who later became Secretary of War, Secretary of State and governor of New York; Hon. John C. Spencer, Secretary of War; Horace Mann, secretary of the Massachusetts State Board of Education; Dr. George B. Emerson of Boston, and Rev. William Gallaudet of Connecticut, attended this meeting. These distinguished guests from New England came upon invitation to express their views upon the normal school idea. The convention endorsed indirectly the plan to organize a normal school. Hon. C. T. Hulburd, chairman of the assembly committee on common schools, submitted an exhaustive report to the legislature of 1844 favoring the establishment of a normal school. A measure authorizing the establishment of such a school at Albany was passed by the legislature in 1844 appropriating $10,000 annually for a period of five years. The establishment of these schools in Massachusetts and in New York did not prevent their enemies from opposing the continuation or development of such schools. Governor Dix of New York who had been friendly to the academies for many years was decidedly hostile to such schools in his message of 1874, and Governor Robinson in his messages of 1877 and 1879 made a direct attack upon normal schools and stated that they were "wholly useless." In the same year the legislature authorized an investigation of such schools. In 1840 the house of representatives of Massachusetts directed the committee on education to consider the expedience of abolishing the State Board of Education and the State normal schools. A majority of that committee prepared a report recommending that both should be abolished and presented a bill to carry out such recommendation. The measure failed to pass. It is in the face of such determined opposition as above outlined that the normal schools have arisen in America. The success of these first institutions in Massachusetts and of the Albany school made it possible to develop the system of normal schools now in existence in the United States. Others were gradually established. The New Britain school was organized in 1849, the Ypsilanti in 1852 and about 70 others previous to 1875. At the present time there are 237 public State normal schools, and before the war the number of students in attendance upon such institutions preparing to become teachers was nearly 100,000. There are also 45 private normal schools attended by nearly 6,000 pupils.

These schools are supported by State appropriations. In some States they are wholly under the supervision of the State educational authorities. In others they are only partially under such supervision and in some the State exercises practically no supervision or control whatever. The age of admission is generally 16 years. The courses of study are generally either two years or four years, depending upon the qualifications of the students when they enter. In some schools, as those of New York, the requirements for admission are graduation from a four-years' approved high school course. In such normal schools the course is two years and is devoted to professional work. In many schools a student is admitted from the elementary schools and for such students the course is generally four years. When normal schools were first organized, their courses of study included much academic instruction. The development of high schools throughout the country has resulted in decreasing the academic work in normal schools and in increasing the professional work. The present tendency is to lengthen the courses so as to cover three or four years. In New York the Board of Regents have recently authorized three-year courses in all the normal schools of that State. In many of these schools special courses such as kindergarten, drawing, music, manual training, home making, rural school and other courses are given. Practice departments or model schools are maintained in all the normal schools and in many cases the normal schools use the public schools for practice departments. These schools generally train teachers for the elementary schools, although some prepare teachers for secondary schools also. Some of the normal schools give extension courses on Saturdays and during vacation periods and some take their students into the rural schools for practice work and for demonstration.

The State College for Teachers at Albany prepares teachers for secondary schools only. The courses cover a period of four years, and the admission requirements are the completion of a four-years' approved high school course. The work in this institution is of collegiate grade and degrees are conferred upon those who complete prescribed courses. There are 800 students in this institution preparing to teach in the high schools of the State.

The Education Law in New York has required since 1895 that all teachers employed in the cities and in the villages having a population of 5,000 or more shall have graduated from a four-years' high school course and thereafter from a two-years' professional course. (Chapter 1031, Laws of 1895). In many cities of the other States a similar requirement is prescribed. Normal schools are unable to meet the demand for teachers and many cities have organized city training or city normal schools. These schools generally maintain entrance requirements and courses of study equivalent to those of the normal schools. These schools prepare teachers for the kindergarten and the elementary schools. New York maintains three of these schools, Philadelphia, two, and a school of this type is maintained in Albany, Buffalo, Rochester, Syracuse, Schenectady, Yonkers, Boston, Pittsburgh, Cincinnati and in most of the large cities of the country.

Within the last 25 years there has been a demand in all parts of the country for better trained teachers in the rural schools. About one-third of the teachers employed in these schools have had no training whatever. This demand has resulted in the establishment of agencies of various types in about one-half of the States for training teachers for rural schools. In New York the training classes maintained in high schools have supplied these teachers for years. Missouri, Vermont and several other States have organized similar classes in their high schools for training rural school teachers. In Michigan, county normal training classes have been organized, but these do not differ materially from the training classes in these other States. Wisconsin has organized not only this type of training class in her high schools, but she has also organized county training schools. These county training schools are in no way connected with other schools, but are generally maintained in separate buildings and have an independent organization. The requirements for admission to these classes vary. In New York it is high school graduation. In most States it is the completion of two years' high school work. In other States the last year of the high school course is devoted to teacher training. In other States students are admitted from the elementary schools. The course of study usually covers one year and the age of admission is from 16 to 17 years. Many of the State normal schools maintain special courses for rural teachers.

Several efforts were made to establish chairs of pedagogy or colleges of education in the universities which would take rank with the department of law, medicine or engineering. New York University established a chair of the philosophy of education for educating teachers of common schools in 1832. Thomas H. Gallaudet occupied this chair from 1832 to 1834. It seems to have been abandoned at that time. Brown University established a similar course in 1850, but discontinued it in 1855. Horace Mann included as an elective study in the regular course of Antioch College, Ohio, in 1853 the theory and practice of teaching. From 1853 to 1873 Iowa University offered courses for teachers and in 1878 opened its college of normal instruction.

On the recommendation of President Angell, Michigan University established in 1879 a "chair of the science and art of teaching" for the following purposes: "To fit university students for the higher positions in the public school service; to promote educational science; to teach the history of education and of educational doctrine; to secure to teaching the rights, prerogatives and advantages of a profession; to give a more perfect unity to the State educational system by bringing the secondary schools into closer relation with the university." A plan was proposed for giving instruction in the science and art of teaching in Columbia University in 1858, but was not carried out at that time. In 1880 the college opened certain courses for training teachers and in 1888 Teachers' College was founded and in 1889 chartered. Doctor Nicholas Murray Butler, now president of Columbia University, was the first head of this new institution and as president of Columbia is now president of Teachers' College. This college is one of the notable institutions of the world. It trains teachers, supervisors, directors and superintendents for all the higher technical and professional positions in the teaching and supervisory staffs of the city and State school systems of the country. Several thousand students are annually enrolled in this institution. All the leading universities of the country now maintain departments of education or colleges which are rapidly taking rank with the departments or colleges of law, medicine and engineering and are meeting the demand for specialists which the developing public educational systems of the country require.

Summer schools have become a strong and influential factor in the training of teachers. Harvard University was one of the pioneer institutions in America to give summer courses. Harvard has given such courses for 48 years. Martha's Vineyard Summer Institute, organized at Cottage City, Mass., in 1878 by Col. Homer Sprague, has been one of the notable institutions of this type. It was closed in 1905. In 1879 the Sunday School Assembly at Chautauqua, N. Y., organized a summer course of psychology and pedagogy which soon became an important centre for teachers. The courses for teachers was increased and the summer sessions now held at Chautauqua give several courses for teachers. After these and some other institutions had been successful in holding summer sessions the work was rapidly taken up by normal schools, colleges and universities, and the most of these important institutions in the country now hold summer sessions. About 800 summer schools were held in 1919 and the attendance upon these was approximately 300,000. The enrolment at Columbia University exceeded 10,000.

Teachers' institutes were established in this country about the same time that normal schools were organized. In 1837 Mr. Stephen R. Sweet opened a temporary school «for qualifying teachers for the winter schools» at Watertown, N. Y. Mr. Sweet contemplated holding a similar school in the late winter or early spring for the purpose of «qualifying teachers for summer schools.» These schools were in session for eight weeks. In 1842 Mr. Sweet opened one of these temporary schools in the Kingsboro Academy, New York, and he called the school the «Kingsboro Temporary Normal School.» The work which he did in this temporary school is quite similar to that which was later done in teachers' institutes. The schools organized by Mr. Sweet became known very generally as temporary schools for training teachers, or temporary normal schools. It is quite probable that Mr. Sweet obtained his idea of this temporary school from the work which was being done to train teachers in the training classes which had been organized in academies in New York.

In 1839 and 1840 Dr. Henry Barnard of Connecticut held a convention of teachers at Hartford. The purpose of these conventions was to improve the scholarship of those who were to teach and to discuss methods of presentation of subjects in the classroom. The work which was done in these conventions was also quite similar to that which was later done in teachers' institutes.

The term «teachers' institute,» however, was first used in New York in 1843. This undoubtedly was the first institute organized in America. It was held at Ithaca and was organized by J. S. Denman, the county superintendent of Tompkins County. The fame of this institute became known and others were organized in different parts of the State. Within three years teachers' institutes were organized in Massachusetts, Ohio, Rhode Island, Indiana, Michigan, New Hampshire and Vermont. It is probable that New York and Pennsylvania organized a more thorough system of institutes than was organized in other States. Institutes were abolished in New York State in 1912, and teachers' conferences under the direction of district superintendents were substituted therefor. The law defining the power of a district superintendent in connection with these conferences is as follows:

"To assemble all the teachers of his district by towns or otherwise for the purpose of conferences on courses of study, for reports of and advice and counsel in relation to discipline, school management, and other school work, and for promoting the general good of all the schools of the district."

Institutes are held in many States. In Pennsylvania and Ohio they form an important feature of the teacher training process. They are organized and managed generally by the superintendent of the supervisory district, county or city. Schools are closed for the period of the institute, which is generally two days in the cities and one week in the rural districts. Appropriations are made in some instances by the State and in others by the county to meet expenses. Fees are also paid by teachers. Attendance is usually compulsory. The method of instruction is generally the lecture system. These lectures are upon subject matter, school discipline, school organization, school management, methods of instruction and popular and inspirational themes. In some instances they depart from the primary purposes of an institute which is to improve the teaching force and take the form of community centres. In such cases they have become mass meetings instead of classrooms for instruction.

In 1895 the Paulist Fathers in New York organized an institute for the general improvement of the teachers in Catholic schools. It is called the National Catholic Teachers' Institute, and under the general management of this organization provision is made for the maintenance of local institutes in various parts of the country for the benefit of the teaching orders connected with Catholic schools.

Teachers' reading circles have exerted a strong influence in developing a professional spirit among the teaching fraternity. The first circle was probably organized in Ohio in 1883 upon the suggestion of Mrs. D. L. Williams, a teacher in that State. The circle was formulated somewhat upon the plan of the Chautauqua literary course. Many of the other States of the Central West and West have organized such circles. These circles are under the management of the State Teachers' Association or the State Education Department. In some States the circle is under the joint management of such authority. A definite course of reading is prescribed, textbooks suggested and examinations prescribed. Many States give some credit in their plan of certification to those who have done successful work in the circle. In 1915 the National Rural Teachers' Reading Circle was organized under the direction of the Bureau of Education at Washington.

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THOMAS E. FINEGAN,
Deputy Commissioner of Education and Assistant Commissioner for Elementary Education, State of New York.

TEACHERS' COLLEGE, a school for the training of teachers, affiliated with Columbia University. For several years the college has maintained courses for teachers in the New York schools, and since 1897 has made these courses an integral part of the regular college courses. The continual increase in the number of teachers taking these courses led to the organization of an extension department in 1903 which includes the entire university system. The university accepts courses in education as part of the requirement for the degrees of A.B., A.M. and Ph.D. The college diploma is conferred upon students who have successfully completed some one of the general courses, and a departmental diploma upon those who have fitted themselves for particular branches of school work. Under-graduate students of Columbia and Barnard colleges may obtain the diploma of Teachers' College when they receive the degree of bachelor of arts.

These are the undergraduate courses: Secondary course leading to the degree of A.B., and the college diploma; general course leading to the college diploma in elementary teaching; general course leading to the college diploma in kindergarten teaching. Then there are several courses leading to the college diploma in art, domestic art, domestic science and manual training. Candidates for the first of these courses must be either college graduates or candidates for the degree of A.B., in Columbia University. There is a combined course of study prescribed for the degree of A.B., in Columbia University and the diploma of Teachers' College.

TEACHERS' EMPLOYMENT AGENCIES. Teachers' employment agencies are of two classes, viz.: (1) Those that carry on the work in a commercial way and collect fees from teachers for the service rendered in obtaining positions; (2) those managed by institutions of learning, as colleges and normal schools, that obtain positions for their own students or graduates without payment other than general tuition fees. Commercial agencies have existed since 1855 but did not become a prominent factor in the employment of teachers prior to 1880. At the present time there are agencies in most of the prominent cities of the country, some doing a local business, others being national in the scope of their activity. The methods employed by all commercial agencies are quite similar. A teacher enrolls by paying the required fee; making a written statement of his age, education, experience and general qualifications, and giving references. The agency on receipt of the statement writes to the references for further data. When a call for a teacher is received by the agency, two or three of the enrolled teachers best qualified for the place are asked to make application, and the strongest candidate is usually recommended by the agency. If the agency's candidate is elected to the position he usually pays the agency a fee of 5 per cent of the first year's salary. A well-managed agency becomes an important factor in placing teachers in the positions for which they are best qualified. Probably the most valuable service rendered by agencies, however, is the proper placing of teachers with special and unusual qualifications.

HORATIO M. POLLOCK.

TEACHERS' INSTITUTES. See TEACHERS, PROFESSIONAL TRAINING OF.

TEACHING METHODS AND SYSTEMS. Teaching, or the imparting of knowledge by the means of lessons or example, has been a matter of study, of discussion, of acceptance or rejection of methods and plans through the entire history of educational science. Talleyrand said that methods are the masters of teachers — "les methodes sont les maitres des maitres." The present trend of educational workers is to make method an aid to instruction. Two general basic schemes for the acquisition of knowledge have long prevailed. The inductive lesson is used in early childhood where associations are made into classes, groups or families of things which are alike in use, structure and appearances. The child easily gains a *percept* of a chair when shown a piece of simple furniture with four legs, a seat and a back. He may find in process of time that various articles appear in its construction, wood, grass, wire, cloth and different shapes have been evolved — low, broad, deep — but from his early percept he is able to classify all as chairs. On the other hand, a thing he cannot understand, he cannot use, he cannot classify, is useless to him. "When a general idea or principle, which applies to several concrete or individual instances so as to explain or give them meaning, is obtained through the study of concrete or individual instances, the process of thought is inductive." Deduction is the opposite of induction; instead of forming one's own conclusions from a series of facts, the student here employs those principles already reached out of his own experience or that established by others. The teacher employs the deductive method when he asks pupils to answer questions, to solve problems, to master situations by referring to rules, laws and axioms; the child uses it when he reduces a fraction to its lowest terms; by applying the rule that a fraction may be reduced to its lowest terms by dividing both numerator and denominator by their common factors until no common factor remains. In the process of deduction, rules which apply may not always readily appear. Different ones may be tried, schemes searched out, tried, rejected — "guiding principles must sometimes be sought long and earnestly before they are found."

The specific methods of the class period divide themselves into three fundamentals, testing, drilling, teaching. Testing the pupils' knowledge provides the instructor a starting point, showing the achievement of the class and its progress, and giving opportunity for classification and adjustment. Skilful tests, oral or written, help the teacher to individualize pupils' needs in such a way as to enable her not only to offer definite instruction to the individual but class instruction as well. Careful observation and a record of mistakes show the direction and nature of the pupils' errors. This test of knowledge lends itself admirably to schemes for review in that proper emphasis may be placed on the needs of the section.

Drilling in the use of the tools of the trade is as essential to the student as it is to the laborer. "Habit," James tells us, "is the result of oft-repeated action in the same line." There are certain fundamentals in educational procedure which must be acquired in such a way as to be habitual. The formation of letters in writing, the acquisition of the multiplication table, the ability to recognize easily a noun or a verb, the familiarity with the paradigms and conjugations of a foreign language, ready application of axioms and laws, all results from oft-repeated action in the same line. They are reached by drill — constant, steady, repeated drill. Instruction without drill leads to chaos, loss of time, inefficiency, educational disaster. Drill should be constant. The multiplication table should be repeated so often that reaction is instant. Methods employed may be flash cards, group recital, simple problems, etc. Drill should be accurate. James again points out that to break an undesirable habit it was necessary never to lapse into it. This implies correct copy, clearly presented and easy of imitation, given under such environment as will lead to skill.

Progress in the career of the student is made by the addition of new knowledge. Knowledge may be imparted by teaching students new facts, varying in method from brief comment to the formal lecture. Comments and explanations are part of most recitations; the danger lies in the fact that the teacher consumes too much time and loses sight of the fact that one large way for a child to learn is to tell what he knows to someone else. The teacher using this method should never lose sight of the fact that children learn to write by writing — to do by doing, to acquire ability in expression and understanding of fact by relating their experience to someone else. New knowledge may be obtained by notetaking, from dictation, from jotting down of facts, from individual research. New knowledge is acquired by illustration and object teaching, by dramatization in literature, by the use of apparatus in physical science, by pictures and maps in history and geographical science, by stimulation of thought in mathematics.

The question and answer method is employed largely in aiding students to formulate their knowledge, to aid them in their expression, to ripen their judgment, and to form correct conclusions. This method is being introduced with the greatest success in language teaching, where spaking practice is essential if the pupil is to acquire anything more than a mere bowing acquaintance with the language under study. Questions and answers are planned so that the teacher speaks very little and the pupils a great deal. The question should be correct in form, definite in meaning, framed in simple terms within the comprehension and adapted to the knowledge of the pupil, stimulating to the thought, addressed to the class and framed so as to draw forth a complete expression. The question and answer method should lead naturally into the topical method which encourages pupils in freedom of expression and gives opportunity as strength comes to discuss topics and make reports on assigned subjects calling for mastery of the subject and independence of thought. This develops skill in organization of ideas, provides powers of expression and furnishes practice in alertness, systematic thinking, and establishes confidence in one's self. This method can be successfully used in the development of all new topics where the new matter is to be connected to the old in the mind of the learner. It may be a half-formed conversation between teacher and class, directed by the teacher and commanding such full and free expression as will fulfil the mastery and development of the topic.

Lesson plans carefully considered and clearly formulated are of great practical value. In the daily plan the teacher considers the subject matter of the review and advance lesson and the class procedure. The daily plan finds its place in the term scheme and the term scheme is a unit of the syllabus for the year. This daily planning prevents a haphazard course and provides for regular orderly progress. A well-organized plan involves a definite aim, bringing to its aid the proper method, which economizes time and effort.

Results obtained by supervised study have become so successful that a brief survey of this method should arouse the interest of school men in such a way as to lead to its wide adoption. By means of it the teacher is enabled to present the subject matter in such a clear, concise way that every pupil is afforded an adequate opportunity to understand and to master the various daily problems of the subject. It is an elaborate and complete assignment of the next lesson, made so clear that the details present themselves so plainly and logically that all have a maximum opportunity to learn the lesson. It has the advantage of giving aid when aid is most needed, of economizing time and effort and forming correct habits of attack and application of principles. With the modern trend of social conditions in the city, crowded part time and frequent abundant attraction, some method and supervision should reach into the home to grip parent and student alike. Frequent reports of progress should go to parents; specific direction given in study; students held to the definite performance of certain tasks and an effort made to train in such economy of time and effort as to make school work a delight; this can be accomplished by carefully scheduled program at home and at school.

JOHN MANVILLE SAYLES,
Professor of Education, State College for Teachers, Albany, N. Y.

TEACHING OF THE TWELVE APOSTLES, a part of the Apostolic Constitutions (q.v.) enunciating principles of Christian faith and practice. It was first (1873) discovered by Bryennius, metropolitan of Nicomedia, in a manuscript of the 11th century and was published in 1875; since which it has been the occasion of much discussion. Consult Harnack, 'Texte und Untersuchungen zur Altchristlichen Literatur' (1886); Schaff, 'The Teaching of the Twelve Apostles' (1885).

TEAK, a large, verbenaceous forest tree (*Tectona grandis*), native to southern Asia and to the Malayan Islands, which furnishes the valuable lumber known as teak. The heartwood is golden-brown when first cut, but when aged darkens to the tint of black walnut. It is very durable, examples in house-timbers having already survived for hundreds of years, is straight in grain and easily worked. It takes a high polish and if properly seasoned will not warp or split. Teak is used for house-building, furniture and wood-carving and is one of the most valuable woods for shipbuilding, especially for decking and for backing the metal plates of iron-clads, since it contains a resinous oil, which prevents it from corroding iron; it is also in demand for car-wheels, gun-carriages, railway ties and engineering works. Although the natural supply of teak, throughout its range was great, as it occurred in mixed forests, most luxuriantly in Burma and adjacent regions, it was rapidly disappearing on account of the unceasing demand and lack of replanting. Great Britain has checked this waste by efficient protection and forest-administration in its Indian and Burmese dominions. The timber is mostly consumed in India. The tree is not usually found in pure forests, but mixed with bamboo, which it overtops and which seems necessary for its growth. It requires a light soil with good sub-drainage. The leaves, which are nearly 10 inches long and resemble those of the tobacco, are somewhat drooping and coriaceous and appear as soon as the rainy season opens. They yield a red dye. Teak trees may easily be distinguished for some time during the rains, by their broad terminal panicles of flowers, which are small, white and fragrant, on slender branchlets. The seeds are oily, in a hard nut covered with a felt of matted hairs and further enclosed in an enlarged membranous calyx. These feathery panicles render the tree again conspicuous during the dry season, when it is leafless. The seeds are plentiful and would soon restore the forests, were it not for the forest-fires, raging just about the time when the nuts are falling. Many of the seeds, however, are washed down by the first heavy rains of the monsoon, into the valleys, where the trees are principally found. Although many logs of teak have cracks or hollows running up through the centre from the butt, that are probably caused by the fires, the market value of the teak, which is greater than that of any other wood except mahogany, depends upon the regular cylindrical shape of the log. This should be without knots or other irregularities and great care is taken in the plantations to rid the trees of creepers which, by their clinging habit, distort the trunks. Teak trees may reach a height of from 100 to 150 feet and a circumference of from 20 to 25 feet; to attain the latter girth, a tree grown under natural conditions must have lived at least 100 years. In the plantations growth is quicker. To get these great logs out of the Burmese forests to the coast it is necessary to raft them down the rivers, but, since green teak will not float and if felled to dry on the ground, the result is uneven seasoning and the lumber still does not float readily, the old Burmese method of drying the wood when standing is still the best available. This is done by girding, a broad annual strip of bark and sapwood is taken off, completely encircling the trunk and the cuts striking down quite into the heart wood. The supply of sap of the upper portion of the trees is of course entirely cut off and the tree dies above the girdle. It stands in that condition for two or three years, according to its size, seasoning evenly and completely, being exposed to the weather on all sides. The logs will then float easily and are sent down the water-ways, sometimes one by one, until they reach a river large enough for them to be formed into a raft. When they reach the lumber yards, elephants are often employed to move the teak about and stack up the logs.

TEAL, a small fresh-water wild duck of the genus *Querquedula*, *Nettion*, or some closely related genus, many species of which occur in various parts of the world. The three North American species are the blue-winged (*Q. discors*), the cinnamon (*Q. cyanoptera*) and the green-winged (*Nettion carolinensis*). The first and last are of common occurrence all over the Continent and breed in suitable places throughout the northern United States and Canada. The males are noted for their brilliance of plumage, as compared with the sober dress of the little females; hence almost any small and gaudy duck is likely to be called a teal in the books of unscientific sportsmen and travelers.

TEARS. See EYE.

TEARS OF SAINT LAWRENCE. See SHOOTING STARS.

TEASDALE, Sara (MRS E. B. FILSINGER), American poetess: b. Saint Louis, Mo., 8 Aug. 1884. She received her education at private schools in Saint Louis and spent several years in European travel. Her published works, marked by a charming lyric quality and a fine rythmic feeling, include 'Sonnets to Duse and Other Poems' (1907); 'Helen of Troy and Other Poems' (1911); 'River to the Sea' (1915); 'Love Songs' (1917).

TEASEL, any member of the genus *Dipsacus*, botanically not far removed from the campanulus. They are tall, rough, hairy or prickly herbs, the most important species being the fuller's teasel (*D. fullonum*), a stout biennial, with sessile, lanceolate to pinnatifid leaves, which are opposite and often connate. The pale lilac, tubular flowers are gathered into dense, terminal, oblong heads, subtended by an involucre and many-bracted. The flowers open, a few at a time, in horizontal zones. Both bracts and involucre are rigid and tipped with spines, the latter being hooked and remaining in fruit. They are then brown and thickly set, radiating from every side of the head, become cylindrical and are very suitable for raising the nap upon woolen cloths or "teazing" them. The heads are fixed for this purpose around the circumference of a broad wheel or on flat cards. The teasel is cultivated and is suspected to be only a variety of the wild *D. sylvestris*, which differs chiefly in the spines of the bracts, which are straight.

TECHE (tĕsh) **BAYOU**, in the southern part of Louisiana, a small tide-water channel, west of Grand Lake, which flows generally south by east into Atchafalaya Bay. It was once the outlet or the main channel, by which the Red River discharged its waters into the Gulf of Mexico. The land through which the Bayou Teche now flows has been formed from the sediment brought down by the rivers and by the overflows. It contains some of the richest soils of the State. On it are raised large quantities of cotton, sugarcane and rice. The Teche is navigable to Saint Martinsville, about 100 miles, and above that point for small boats, when there is high water.

TECHNICAL EDUCATION. See EDUCATION, TECHNICAL.

TECHNOLOGY, Schools of. Schools of technology in the United States are of comparatively recent date. The earliest was the Rensselaer Polytechnic Institute of Troy, N. Y. (q.v.), founded in 1824; then followed the Massachusetts Institute of Technology, Boston, Mass., 1861; the Worcester Polytechnic Institute, Worcester, Mass., 1868; Lehigh University, 1866; Stevens Institute of Technology, 1871, and the Case School of Applied Science, in 1880 (qq.v.). From that time on the number increased rapidly and in 1900 there were 43 institutions in the United States classed as schools of the technology by the Commissioner of Education. Among these are privately-endowed institutions, like the Stevens Institute of Technology; State institutions, like the Sibley College of Cornell University; scientific departments of older universities and schools partly industrial, like the Pratt and the Armour institutes.

Technical schools in Germany have long been graded as (1) elementary industrial schools; (2) secondary industrial schools; (3) higher polytechnic institutes. The tendency in the United States is along the same lines, providing all needed forms of education, including more or less technical training, in connection with universities, colleges and schools already existing. Many of the State colleges are affording in one institution the whole range of pure and applied science. The requirements for entrance to most of the technical schools of the United States are algebra, plane geometry, English literature, the history of the United States, French and a knowledge of the common English branches. Some schools require solid geometry, plane trigonometry, elementary physics and chemistry and some require Latin in addition to the above. The general courses of study pursued are civil engineering, mechanical engineering, electrical engineering, railway engineering, mining engineering, chemical engineering, sanitary engineering, architecture, pharmacy and chemistry. The length of each course is usually four years. Marine engineering forms an additional course in the University of Maine, University of Michigan, Cornell, Columbia and New York universities. Naval architecture is offered as a course in the Massachusetts Institute of Technology, in Columbia, New York and Cornell universities and in the University of Michigan, etc. Schools of forestry are connected with Yale, Michigan, Cornell and Syracuse universities; with the University of Nebraska and the Ohio State University. Horticulture is taught in Harvard University. Ohio State University, Iowa State College, University of Nebraska, etc. Domestic art, domestic science and the fine arts, in addition to steam and machine design and applied electricity are given prominence in Pratt Institute, Brooklyn, N. Y. At the Armour Institute, Chicago Ill., typewriting, music and domestic art are added to the usual engineering courses. The universities and colleges of the United States have so universally added technological courses to their systems of instruction that it is no longer possible to separate the technological schools. The United States Commissioner of Education has ceased to classify them separately and only a few are known as distinctly polytechnic institutions.

Schools of Agriculture and Mechanic Arts.— The pioneers of technical education in the United States were privately endowed schools of technology, but technical education received its greatest impulse by the «Land Grant Act» and «Morrill Bill» of Congress from the year 1862 to 1890. (See COLLEGES, LAND GRANTS). Under these acts the Federal government has given more than 13,000,000 acres of public lands for the establishment and maintenance of colleges of agriculture and mechanic arts. The name has not always been retained as acts of State legislatures and private benefactions and other causes have led to a change or to an affiliation with State institutions. But as a result, at least one such institution has been established and is now in operation in each State and Territory of the United States, except Alaska. The International Typographical Union has established a large school of typography at Indianapolis and the International Printing Pressmen and Assistant's Union, a school of presswork, near Rogersville, Tenn. Other trade unions are initiating the method and in this way many very important trade schools are developing. Of the institutions that have been organized under these acts, 51 are colleges of agriculture and mechanic arts, having in 1917 over 5,000 instructors; 54,931 white men students; 14,460 white women students, and 4,405 colored men and 6,208 colored women students. Separate institutions for colored students have been established in most southern States. The courses of study pursued in these schools are agriculture, all the branches of engineering, textile engineering (in North Carolina and Mississippi); forestry (in Michigan), and horticulture (in Washington and Virginia). Clemson Agricultural College, in South Carolina, has a full equipment of cotton machinery for illustrating the manufacture of yarn and woven fabrics. Requirements for entrance differ very greatly in different States. (For detailed information regarding technical education in the United States, see EDUCATION, ENGINEERING; MANUAL TRAINING; TECHNICAL EDUCATION; TRADE SCHOOLS). Consult also 'Annual Report of the United States Commissioner of Education'; 'Report of the United States Commissioner of Labor on Trade and Technical Education'; 'Annual Reports of the Society of Mechanical Engineers.'

TECTONIC GEOLOGY. See GEOLOGY — *Structural Geology.*

TECUMSEH, tĕ-kŭm'sē, Shawnee chief: b. near Springfield, Ohio, about 1768; d. 5 Oct.

1813. About 1805 he formed the design of uniting the tribes of western Indians against the whites. He claimed that the land-treaties between individual tribes and the settlers were void, inasmuch as the land was the common property of all the tribes and could be alienated only by unanimous assent. British agents fanned the dissatisfaction, which was likewise increased by the ejectment of Indians by speculators. Gen. W. H. Harrison (q.v.) warned him to discontinue his scheme and held a parley with him without result near Vincennes, Ind. He was aided in his plans by a brother, Tenskwatawa, who was reverenced by the Indians as a prophet. Tenskwatawa directed the attack at Tippecanoe (q.v.) 4 Nov. 1811, though he remained on a hill during its progress. Tecumseh was not present. He incited the Creeks in their futile revolt, joined the British, was made a brigadier-general, led 2,000 Indians at the siege of Fort Meigs, commanded the right wing at the Thames and was killed there. He possessed great qualities of leadership. Consult Drake, 'Life of Tecumseh.'

TECUMSEH, Mich., village in Lenawee County, on the Raisin River and on the Lake Shore and Michigan Southern and the Chicago, Jackson and Missouri railroads, about 35 miles northwest of Toledo and nine miles northeast of Adrian. It is in an agricultural region noted for its fruit, especially peaches. The chief manufactures are flour, furniture, wagons, carriages, brick, tile, paper, lumber, foundry and machine-shop products and dairy products. It has a high school, graded schools and a public library. The two State banks have a combined capital of $70,000. Pop. about 2,332.

TECUMSEH, Neb., city, county-seat of Johnson County, on the Big Nemaha River and on the Burlington and Missouri River Railroad, about 45 miles southeast of Lincoln and 60 miles south of Omaha. It is in a rich agricultural region. It is the commercial centre of a large portion of the county; the chief shipments are grain, livestock, vegetables and fruit. The city has eight churches, a high school, four public school buildings and a public library. There are two banks, a national and a State, with a combined capital of $100,000. Pop. 1,748.

TEES, tēz, a river in northern England, which rises east of Cross Fell forming along its entire course the boundary between Durham and the North Riding of Yorkshire, passes by Barnard Castle, becomes navigable between Dalton and Yarm, and, after flowing a distance of 70 miles, empties into the North Sea at Middleborough, forming the Tees Bay.

TEETH, hard structures developed in the mouth and adjacent parts of vertebrated animals and concerned in the obtaining and mastication of food and secondarily in a variety of other functions. "They present," says Owen, "many varieties as to number, size, form, structure, position and mode of attachment, but are principally adapted for seizing, tearing, dividing, pounding or grinding the food. In some species they are modified to serve as formidable weapons of offense and defense; in others, as aids in locomotion, means of anchorage, instruments for uprooting or cutting down trees or for transport and working of building materials. They are characteristic of age and sex; and in man they have secondary relations, subservient to beauty and to speech. Teeth are always intimately related to the food and habits of the animal and are, therefore, highly interesting to the physiologist; they form, for the same reason, important guides to the naturalist in the classification of animals." For further information as to the development of the varied forms of teeth in relation to use, see KINETOGENESIS.

Teeth are a production of skin, and homologous with the scales of fishes, and various other hardenings of the surface; in some of the fishes and lower invertebrates there is an insensible gradation from one to the other. In one large class, the birds (q.v.), they are now wholly absent, their functions being performed by the horny covering of the jaws (bill) or by the gizzard, or both; but in the earliest extinct birds they were present in both jaws and had a close resemblance to those of reptiles. Turtles, also, and many amphibians are toothless; and in some of the inferior mammals teeth are present only as embryonic rudiments, which disappear before or soon after birth. Many small, sharp hardened structures in the worms, echinoderms, mollusks, insects and other invertebrate animals, which are more or less concerned in biting, are popularly spoken of as teeth, but, strictly speaking, should be otherwise designated. In general the present article will treat of the teeth as found in the mouth of man and the higher vertebrates, where they arise from the gum or covering of the jaw-bones, each rooted in a socket or sockets of its own formed by the alveolar processes of the maxillary bone.

Structure of Teeth.— A tooth begins, early in embryonic life, by the development from the mucous membrane of the gum of a group of modified epithelial cells which dip down into the substance of the gum and form an organ, the germ of the tooth, which will furnish the enamel needed. Below that there next develops a mass of special tissue which takes the shape of the future tooth. In due time it begins to calcify upon the surface, and this process proceeds, downward and inward, until all of the substance of the papilla has been changed into solid dentine except a central cavity which remains filled with growing tissue (pulp), supplied with blood and nerves. This dentine is the principal constituent of the greater number of teeth, and is seen to best advantage in the massive ivory of the tusks of the elephant and walrus, and consists of an organic basis richly impregnated with mineral (chiefly phosphate of lime) disposed in the form of minute tubes, each open at its inner end and occupied by a fibril of living nutritive tissue connected with the pulp. In the ordinary case these dentinal tubes radiate from the pulp cavity in a slightly wavy course to the outer surface. "The hard substance of the tooth is thus arranged in hollow columns, perpendicular to the plane of pressure, and a certain elasticity results from these curves; they are upright where the grinding surface of the crown receives the appulse of the opposing tooth, and are horizontal where they have to resist the pressure of contiguous teeth. The tubuli also receive the plasma transuded from the remains of the vascular pulp, which circulates by anastomosing branches of the tubuli through the dentine, maintaining a sufficient though languid vitality of the system. The delicate nerve branches on the pulp's surface convey sensations of impressions affecting the dentine — every one has experienced the acute sensations when decay has affected the dentine or when mechanical or chemical stimuli have «set the teeth on edge.» When a part of the primitive vascular pulp from which the dentine is developed remains permanently uncalcified, red blood is carried by «vascular canals» into the substance of the tissue. Such dentine is called vaso-dentine and is often combined with true dentine in the same tooth, as, for example, in the large incisors of certain rodents, the tusks of the elephant, and the molars of the extinct megatherium. When the cellular basis is arranged in concentric layers around the vascular canals, and contains «radiated cells,» like those of bone, this is termed osteo-dentine, and resembles true bone very closely.

While this dentine is developing the tissue around the tooth-germ is forming a capsule or wall called the tooth-sac, the inner layer of which ossifies, forming a bony coat, the crusta petrosa or cement, on the external surface of the tooth. It is often found only as a thin layer on the surface of the root, which develops downward as the tooth grows, forcing the tooth upward, through and above the gum; but sometimes, as in the molar teeth of the horse, elephant and mastodon, it is a structure which plays a very important part covering and filling in the interstices between the folds of the enamel. It is much like true bone in its constitution. Meanwhile the epithelial cells of the superficial layer of the skin over the tooth-germ are depositing upon the dentine of the upper part of the tooth, which is to be exposed, an extremely hard bluish white, translucent, protective layer, composed of about 96 per cent of mineral matter, called the enamel, and destined to resist the wear to which teeth are subjected in their work. It is the hardest organic substance known.

Teeth are of various forms, but reducible to two types, of which the simpler and more primitive is represented on a large scale by the tusk (incisor) of the elephant or beaver, in which the pulp retains its conical form and activity, or is «persistent,» and continues to supply dentine at the base of the tooth, which thus grows throughout life to compensate for its wearing away at the tip. These teeth are said to be «rootless.» The other type, exemplified in man, is called «rooted,» and in this case, after the «crown,» or exposed part of the tooth has been fully formed, the pulp within the «neck,» or that part just beneath the surface of the gum, begins to fill with dentine, and to form a downward growing pointed mass, the «root» or «fang,» which at last is solid except for a narrow central canal in which the contracted remainder of the pulp persists, largely supplied with nervous filaments from the pair of cranial nerves. Various intermediate conditions between these two types exist.

In form teeth vary from a simple spine-like or conical shape, to many chisel-like or massive and complicated forms, all of which are determined in the germ, and before the tooth makes its appearance above the gum or is «cut,» which in mammals never normally occurs before birth. This appearance in some, as the seals, may take place all at once; but in most cases occurs at intervals, the front teeth usually showing before the back ones, which sometimes are not cut (for example, the «wisdom teeth» in man) until several years later. In man and higher mammals two sets of teeth are developed: the early, *milk*, or *deciduous* teeth, and the permanent set. Such forms are, therefore, named *diphyodont;* while those in which one set only is developed are named *monophyodont.* When more than one set occurs those of the second are developed in precisely the same place and manner as the first, except as to certain details of the enamel germs. The milk or temporary teeth are gradually displaced from below by the upward growth of the permanent teeth, the fangs of the milk teeth being absorbed, and the latter falling out as their successors are more fully developed. This arrangement is adaptive to the growth of the animal's jaws, among other advantages. The milk set in man consists of 20 teeth; and numbers four incisors, two canines, and four premolars or bicuspids in each jaw. The permanent set includes, in addition to the foregoing teeth, six true molars in each jaw — the latter being thus unrepresented in the milk set. The milk-teeth begin to appear about the sixth month of life, and continue to be developed till about the end of the second year. The permanent teeth begin to appear about the sixth year of life, the first being the front molar of each side, while the last molars or wisdom-teeth are not usually developed until adult life has been attained. Man has thus 32 teeth in his permanent set — 16 in each jaw.

The incisors or front teeth are single-fanged, and have chisel-shaped crowns, suitable for biting. To the incisors succeeds on each side the single canine tooth, which has also a single root and a more pointed crown. This is a piercing, holding or tearing instrument, most highly developed in the dog (*canis*) and other beasts of prey. The fourth and fifth teeth, premolars or bicuspids, derive their latter name from the presence of two pointed cusps or tubercles on their crowns. The fourth tooth, or first premolar, shows a tendency to become double-fanged, while the fifth, or second premolar, is double rooted, and the crowns of both are broad. The molars — three on each side of each jaw — have the broadest crowns of all, and possess each two or three fangs, each growing from a separate pulp and rooted in its own socket. The sixth upper molar is the largest tooth of the whole set. These massive teeth crush or grind the food, and vary greatly in the character of the surface of the crown according to the nature of the food. Thus in the insectivorous mammals, as the shrews, the crowns are covered with numerous sharp edges and points which, working against one another, like shears, as the lower and upper molars are closed together in chewing, cut up the hard shells of insects into little pieces fit for swallowing and digestion. Such a type of crown is called *secodont.* Another type, the *bunodont,* is seen in the molars of omnivorous animals, such as man, monkeys, pigs, etc., where the surface of the crown is broad, flattened, and elevated into rounded tubercles. In the herbivores the crown is crossed by parallel ridges, which are greatly varied and complicated, up to the huge molars ot the elephant family; in these cases the ridges are formed by partition-like infoldings of the enamel and the interspaces are filled with cement. When such a tooth wears away at the surface, the different density of the layers of the substances of which it is composed — enamel, cement and dentine — causes them to wear unequally, the hard enamel ridges projecting beyond the others and thus, as Flower says, "giving rise to a grinding surface of great mechanical advantage." The patterns of these ridges are characteristic of species; and by the changes of pattern which occur as they wear down, the age of the animal may often be closely estimated, a fact constantly utilized in the case of horses. This infolding of the enamel reached its highest complication in the curious "labyrinthodont" teeth of the ancient stegocephalian reptiles.

The dentition of any animal is expressed by a *dental formula*. That of man runs thus:

$$\text{I.}\frac{2-2}{2-2}:\text{C}\frac{1-1}{1-1}:\text{P.M}\frac{2-2}{2-2}:\text{M}\frac{3-3}{3-3}=32.$$

This means that the incisors (I.) number two on each side of each jaw — the numbers *above* the horizontal line corresponding to the teeth in the upper jaw, those below the line indicating those of the lower jaw; while the further subdivision of the teeth above and below the line is meant to indicate the numbers in each side of each jaw respectively. The other signs and numbers, therefore, read that the canines (C.), premolars (P.M.) and molars (M.) number two, four and six in each jaw; making a total of 32 teeth. Similarly the dental formula of a ruminant (q.v.) such as the sheep would run thus:

$$\text{I.}\frac{0-0}{3-3}:\text{C}\frac{0-0}{1-1}:\text{P.M}\frac{3-3}{3-3}:\text{M}\frac{3-3}{3-3}=32.$$

It is presumed by this notation that each tooth has its strict homologue, in all kinds of mammals at least; and if any are missing their character or name may be accurately defined. This theory encounters difficulties, for example, in comparing the dentition of marsupials with the higher mammals; but it serves conveniently in the description of ordinary animals.

Among the lower vertebrates teeth appear in great variety, as to number, form and functional modification. Those of fishes and fish-eating animals as the dolphins, are simple sharp-curved cones, useful in seizing and holding their slippery prey, which is usually swallowed whole. In fishes and most reptiles the teeth are usually attached by ligaments, and shed and renewed, not once only, as in mammals, but frequently during the whole course of their lives. In sharks the teeth are placed in a common groove, and row after row may be developed in fishes as the front and older teeth are worn away or destroyed. Fishes and amphibians may have teeth in two rows in each jaw, and also on the back part of the mouth and on the skull or even on the tongue, gillarches (*Perch*), pharyngeal bones, sides of the mouth and in other situations. The lower vertebrates have the teeth fastened in various ways to the jaws, and not implanted in sockets as in man. In reptiles, as a general rule, the base of the tooth is anchylosed to the bone which supports it. The completion of a tooth is soon followed by preparation for its removal and succession, the faculty of developing new tooth germs being apparently unlimited in this class. The teeth of crocodiles grow successively, a new one arising inside the pulp-cavity of the old one and displacing it. In many lizards teeth become anchylosed to the summit of the jaw (acrodont dentition), or to the outer side of the bone (pleurodont). Reptilian teeth sometimes undergo great modifications, as in the hinged poison-fangs of vipers and rattlesnakes (qq.v.). Extraordinary modifications among mammals are seen in the horny pseudo-teeth of the duck-bill; the entire absence of teeth of some edentates; the transitory teeth of the baleen whales succeeded by whalebone; the "horn" of the narwhal, the tusks of the elephant, walrus, wild boar, etc., each in relation to peculiar habits.

There is also a close connection between the articulation or joint of the lower jaw and the nature of the food used by the animal. Thus, in purely carnivorous animals, in which the teeth simply tear and cut the food, no grinding motion is required, and the jaw is capable only of a simple hinge-motion in the vertical plane; while in herbivorous animals the joint is so constructed as to allow of extensive sliding and lateral motion of the lower molar teeth upon the upper. In man both the form of this articulation and the general character of the teeth point to an intermediate position in relation to food, and form a physiological argument for the mixed diet which general custom has decided to be most natural to our species.

Diseases of the Teeth.— Decay (caries) is by far the most common of the diseases which affect the teeth, and consist in a gradual and progressive disintegration of the tooth substance. Among the chief predisposing causes are hereditary defects of quality; imperfect calcification; pits and grooves in the enamel; overcrowding of the teeth, facilitating the retention of particles of food between them; constitutional disorders affecting the digestive organs and debilitating causes generally. Dental caries consists in the decalcification of the teeth by lactic acid generated in the mouth by fermentation due to micro-organisms. Decay is rarely met with on smooth surfaces exposed to the friction of food and the direct washings of the saliva. It usually begins in some pit or groove in the enamel or between the teeth, such points forming a lodgment for the development of the organisms. Once the enamel has been penetrated the decay proceeds more rapidly, spreading laterally beneath the as yet healthy enamel and toward the pulp. The more dense the structure of the tooth the more directly does the decay penetrate in the direction of the pulp, though its process is not so rapid and its tendency to spread is less. Caries is most common in early life, by far the greater number of cavities making their appearance between the ages of 6 and 18. The treatment of caries can only be undertaken by the dentist, and varies with the extent and character of the disease.

Periostitis and Alveolar Abscess.— Periostitis is an inflammation of the membrane (periosteum) which covers the roots of the teeth and lines their sockets. By far the most common cause is the presence of a dead nerve, the poisonous products of which cause violent inflammation at the end of the root. When acute periostitis has fairly set in, it and its usual accompaniment, alveolar abscess, are perhaps the most painful affections to which the teeth are subject.

Alveolar abscess may be defined as a suppuration around the root or roots of a tooth. Its causes are those of periostitis which precedes it, the continuous and throbbing nature of the pain indicating the formation of matter (pus) within the surrounding bone. The face, with the glands about the neck, swell, and the glands exhibit tenderness on touch. The pent-up pus forces its way through the bone to reach the surface of the gum at the point of least resistance, which is most often opposite the end of the root or roots (this is popularly known as a «gum boil»). With the escape of pus there is a marked abatement in the intensity of the pain, which generally disappears in a few hours and the swelling in a few days.

Impaction and Difficult Eruption.— It is not uncommon to find certain of the temporary teeth firmly set in the adult jaw, and occupying the place of the permanent ones. In such cases the permanent tooth is usually present in the body of the jaw, but it has been retarded in eruption by being too deeply embedded in the bone. Impaction may also be due to abnormal direction of growth. Such teeth may appear late in life after all the others are lost, and the bone overlying them has been absorbed and so exposed them. When these cases do occur they are responsible for the popular but incorrect idea of a third set of teeth. An impacted tooth seldom gives rise to any trouble, unless it be an upper or lower wisdom, particularly the latter. The cutting of these teeth is sometimes accompanied by distressing symptoms, which may be protracted for months or years, unless they are removed by extraction of the tooth. This condition is usually due to imperfect development of the jaw. The tooth usually takes its natural vertical direction, but, being wedged in between the tooth in front and the ascending portion of the jaw behind, only a small portion of the crown is visible. The overlying gum is apt to be bruised by the occlusion of the opposing tooth in the upper jaw; inflammation is thereupon set up, and being maintained by biting may extend to the surrounding parts. Swallowing becomes painful and the motion of the jaws restricted. When it is evident that there is insufficient accommodation in the jaw for the erupting tooth it should be removed.

Inflammation of the gums, though not a disease of the teeth proper, is one of the most common causes of the premature loss. It may arise from constitutional causes — chronic dyspepsia, rheumatism or gout — or from the administration of such drugs as mercury or iodide of potassium. Most often, however, it results from the presence of tartar about the necks of the teeth, and lack of thorough cleansing. When due to constitutional causes, their appropriate remedies are called for; but when due to the presence of tartar, this deposit should be carefully removed.

Toothache.— Other diseases of the teeth are less commonly suffered, and more obscure. The advice of a dentist should be sought on suspicion that the teeth are in any respect out of order. An aching tooth is a symptom of disease which requires instant attention. When due to caries with or without simple exposure of the pulp, the attack is brought on by taking hot or cold, sweet or acid fluids, and is seldom of long duration. To afford relief in such cases as these, gently wash out the cavity with a solution of carbonate of soda; then, drying it carefully with a piece of cotton-wool, take a very small pellet of wool dipped in eucalyptus oil and place it in the bottom of the cavity; over this place a piece of cotton wool large enough to fill the cavity and saturated with the following solution: one dram of mastic in one and one-half ounces of eau de Cologne. This should be changed daily. When the pain is caused by the forming of an alveolar abscess the tooth will be found insensitive to change of temperature but very susceptible to pressure. The patient now becomes feverish, and the pain, which is at first of a dull heavy character, becomes more intense, throbbing, and continues, till pus has been formed and discharged through the gum. Provided the tooth is likely to prove useful and the patient cannot consult a dentist, the gum should be carefully painted with tincture of iodine, or the old-fashioned plan of placing a roasted fig over the root may be resorted to; at the same time it is well to give an aperient such as Epsom salts, followed by a full dose of quinine — six to eight grains for an adult. Great relief follows this treatment, which is, of course, only temporary. If an abscess shows signs of pointing on the gums it may with advantage be lanced. Poultices should never be applied to the face, for heat tends to draw the pus outward. Abscesses in connection with the lower wisdoms often assume a very serious character unless cut short by extraction of the tooth.

Hygienic Care of the Teeth.— Many of the diseases of the teeth and gums might be prevented or greatly retarded by proper attention to the cleansing of these organs. The implements best fitted for this purpose comprise the quill toothpick, waxed silk thread and brushes, with suitable powders. The toothpick ought to be used after every meal, but it should be supplemented by the use, between the teeth, of floss silk, which will remove deposits accumulating where contiguous teeth touch. The brush is used to remove all deposits solid and mucous, and it gives the teeth a bright and polished appearance; its mechanical friction, too, stimulates the gums to more healthful action. An excellent tooth powder is composed of precipitated chalk, two ounces; light magnesia, two ounces; oil of cinnamon, eight drops; thymol crystals, four grains; otto of roses, 10 drops. The teeth should be brushed twice daily, in the morning and in the evening. The manner of using the brush is more important than many people suppose. The general method is to brush horizontally, but a moment's reflection will show that this leaves untouched the very situations most in need of cleansing. The brush, used properly, should be pressed against the teeth and the handle rotated so as to make the bristles sweep vertically between and over them; this coupled with an up-and-down motion will thoroughly cleanse the interspaces; the inner surfaces of the back teeth are best cleaned in a like manner, while the corresponding parts of the upper and lower incisors are effectually reached by a vertical drawing movement. The brush should be of medium texture, and the bristles of unequal length, and not too closely placed. A hard-and-fast rule cannot, of course, be laid down for every one to follow, but in the majority of cases it is advisable to use the powder in the morning and a mouth wash with the brush in the evening. For the latter purpose the following is good (especially where a tendency to inflammation exists) — tannic acid, four grains; rose water, one ounce; tincture of pyrethrum, one-half dram; oil of cinnamon, 10 drops. Over-brushing must be guarded against as carefully as under-brushing, lest the gums and the necks of the teeth be injured. During an illness these precautions are doubly necessary as the corrosive effects of many medicines are then added to the evil results of a weakened vitality. The use of a glass tube in taking medicine that contains mineral acids and iron is usually supposed to be a sufficient precaution against the action of such drugs on the teeth, but this is quite erroneous; the only sure preventive being a weak solution of ordinary baking soda, with which the mouth should be rinsed after every dose. The choice of a tooth powder should be left to the dentist, for many dentifrices which, no doubt, whiten the teeth, do so by the action of some agent which is as deadly to the tooth substance as to the impurities it is meant to remove. Charcoal (so much used) is quite unsuitable because of its gritty nature. As far as the ordinary individual is concerned, the use of brush and toothpick is the limit up to which one can take of one's own teeth, so that a thorough examination of the mouth once or twice a year by a trustworthy professional man is necessary to check the diseases of the teeth before they have gone so far as to be irreparable. Especially should this be attended to in children. It is almost impossible to overrate the importance of following, at least in the main if not in detail, the hints given above, for when we consider that the teeth are placed at the very gateway of life, it is not surprising that their neglect should be answerable for many of the disorders of the system. Surely precaution is better than cure. See also DENTISTRY.

TEFFT, Benjamin Franklin, American Methodist Episcopal clergyman, college president and diplomat: b. Floyd, N. Y., 20 Aug. 1813; d. Brewer, Me., 16 Sept. 1885. He was graduated at the Wesleyan University in 1835 and in 1839 entered the Methodist Episcopal ministry. He held pastorates at Bangor and at Boston and in 1843–46 he was professor of Greek and Hebrew at Asbury, Ind. (now De Pauw), University. He edited the *Ladies' Repository* in 1846–52; was president of Genesee College, Lima, N. Y., in 1851–54, also editing the *Northern New Yorker* in 1852–54; and held pastorates at Bangor in 1858–61. He was appointed United States Consul at Stockholm and acting Minister to Sweden in 1861; and in 1864 was made commissioner of immigration from northern Europe for the State of Maine. In 1873–78 he edited the *Northern Border* at Bangor. Author of 'Prison Life' (1847); 'Hungary and Kossuth' (1852); 'Webster and His Masterpieces' (2 vols., 1854); 'Methodism Successful' (1860); 'Evolution and Christianity' (1895), etc.

TEGEA, Arcadia, city of ancient Greece whose site was near the modern Tripolitza. It was situated on the southern portion of a plateau nearly enclosed by mountains, the northern half being occupied by Mantineia. It was a highly fertile region, but was subject to floods because of an insufficiency of outlets through its mountain barriers and together with Mantineia was dependent upon underground drainage conduits. This common dependency was a cause of frequent wars with Mantineia, while Tegea's natural position controlling the chief roads leading from Laconia to Argus and the Isthmus made her for long a bulwark between Arcadia and Sparta and caused many wars with the Spartans. Sparta, however, subdued Tegea about 550 B.C. and forced the city to join the Spartan League but did not otherwise deprive it of its independence. Later it joined the Arcadian and Argive League against Sparta, but after a decisive defeat about 468–467 B.C. it again became Sparta's ally. It was a member of the Arcadian Confederacy after the battle of Leuctra in 371 B.C. and later belonged to the Ætolian League. It remained a place of importance after the Roman conquest of Greece, but in 400 A.D. it was destroyed by Alaric. The excavation of its ruins was begun in 1879. Its most important building was the temple Athena Alea, rebuilt by the sculptor Scopas in 395 B.C. It was a combination of Doric, Ionic and Corinthian architecture 72 by 154 feet; the sculptures also were by Scopas and represented the slaying of the Calydonian bear and the combat of Telephus and Achilles. While these are in fragments they were evidently in the best manner of Scopas. Consult Curtius, E., 'Peloponnesos' (1851); Mendel, G., 'Bulletin de correspondence hellénique' (Vol. XXV, 1901); Gardener, E. A., 'Fragments of Greek Sculpture' (1915).

TEGERNSEE, Germany, village and mountain lake resort in the province of Upper Bavaria, on Lake Tegernsee, 32 miles southeast of Munich, 2,390 feet above sea-level. It has a castle which originally was a monastery founded in 719; a parish church of the 15th century; and an ophthalmic hospital founded by Duke Charles Theodore of Bavaria. It is much frequented as a summer resort, the lake and the fine mountain scenery offering many attractions. Pop. about 1,900.

TEGNÉR, těng-nār′, **Esaias,** Swedish poet: b. Kirkerud, Wermland, 1782; d. Wexiö, Småland, 1846. He was graduated at the University of Lund in 1803, became (1812) professor of Greek literature and member of the Swedish Academy, was ordained priest and in 1824 was appointed bishop of Wexiö. As a poet he struck out a new path in Swedish literature. His first attempts did not meet with much acceptance, but at length he came to be regarded as the greatest poet of Sweden. His poetry is characterized by inexhaustible wit, rich, fancy and lively feeling. His most notable work and the direct cause of his promotion to the bishopric was 'Frithjof's Saga,' a species of epic, repeatedly translated into English. Its great value lies in its accurate reproduction of the legends that are included. He also wrote the national song 'The Gotha Lion' and 'The Children of the Lord's Supper,' translated by Longfellow. His works were collected and published by Böttiger, his biographer (1847–50; jubilee ed. 1882–85). The later years of his life were spent in a retreat for the insane and on a paralytic couch. (See FRITHJOF'S SAGA). Consult Boyesen, H. H., 'Essays on Scandinavian Literature' (New York 1895); Erdmann, 'Esaias Tegnér' (Stockholm 1896).

TEGUCIGALPA, tä-goo-sē-gäl'pä, Honduras, the capital of the republic since 1880 and of the department of the same name, situated on the Choluteca River, 60 miles northeast of the Gulf of Fonseca. It is one of the old Aztec cities and lies on a plateau 3,250 feet high. An imposing bridge connects it with the suburb of Comayagua. The government maintains a central institute with subsidized colleges and five normal schools. Its cathedral is the finest building in the country and there are besides five other churches, a university and other less pretentious public buildings. Gold and silver mines are worked in the neighborhood, which is also a fertile agricultural district. Pop. 28,950.

TEGUEXIN, tĕ-gĕk'sĭn, a lizard. See TEJU.

TEHERAN, tĕh-ĕ-rän', Persia, (1) Capital of a province of the same name, at the northeast and about 66 miles south of the Caspian Sea. It lies on an elevated plain, with the lofty ranges of Elburz and Demavend rising at the north and east, 20,000 feet being the elevation reached by the latter volcanic peak. The old fortifications were demolished and others were completed in 1874. A fine promenade was made on the site of the old walls and the new fortifications are much more extensive, enclosing an area of about 10 miles. The principal streets extend from the 12 gates to the central bazaar, which displays a great variety of domestic and foreign goods. The ark is the principal feature and is the name given to the citadel and its enclosures, chief of which is the handsome palace of the shah, with its extensive grounds and fountains. There are various schools, including a Koran school and a college conducted by European professors. Besides numerous mosques, the buildings of the British legation and of other legations are worthy of notice and the suburbs lying at the foot of the Elburz hills, contain many charming villas resorted to by the wealthier class in warm weather. The ruins of Rei, in the vicinity, are among the most remarkable of Persia. Water supplied to the town by 30 subterranean canals, is brought from the northern slopes and in 1866 a tramway was constructed to Shah Abdul Azim, a place of pilgrimage south of Teherán and others were built connecting various sections of the town. Gas was first used in 1892 to light the city. Harûn-el-Raschid was born in the vicinity. The manufactures include carpets, silks, cotton goods and ironware. In 1913 the police service of Teherán was turned over to the control of Swedish officials, the Swedes having largely officered the Persian army. Pop. (est.) 280,000. (2) The province of Teherán comprises six districts, containing much fine agricultural land and numerous villages, two of which are held in fief by the British and Russian governments respectively. There are fine coal fields in Kasran and streams abounding in fish. Veramin District is watered by the Jájrúd River. The chief products are fruit and grain, wheat, barley and rice. A railway, passing through Mesopotamia, connects the Mediterranean with the Black Sea and the Gulf of Persia. It furnishes an all-rail route from Calcutta to the British Channel and shortens the distance from Teherán to Constantinople by two weeks.

TEHUANTEPEC, tä-wän-tä-pĕk', **City of,** situated in the state of Oaxaca, Mexico, 18 miles from the Pacific Ocean, is the centre of a fertile and productive country in which coffee, sugar and other tropical products are largely grown. It has a considerable trade in cattle which are raised on adjacent lands. The city is an important station of the new inter-oceanic railway. Pop. about 18,000, including a large number of persons of Indian extraction.

TEHUANTEPEC, Isthmus of, comprises that section of the Republic of Mexico within the states of Vera Cruz and Oaxaca where the Gulf of Mexico and the Pacific Ocean approach nearest one another, the distance from the mouth of the Coatzacoalcos River, on the east, to the port of Salina Cruz, on the west, being 143½ miles. This point is one of the rare instances where a depression exists in that vast chain of mountains which extends from north to south along the western shores of both American continents. At Tarifa, the lowest point of the summit level, the altitude is but 754 feet above the sea. Cortes, searching for a safe harbor for his ships, discovered the Coatzacoalcos River, wide and deep where it empties into the Gulf, and pronounced it the finest in Mexico. Informed of the narrow strip separating the two oceans, the conqueror was evidently impressed and at once grasped the idea of inter-oceanic communication at this point. With prophetic insight and influenced by the enormous advantages which were certain to result to the isthmus by the construction of a ship canal, Cortes located a vast land grant, presented by his sovereign, in close proximity, and chose for a title "Marquis of Tehuantepec." His successors caused superficial surveys of the route to be made and were convinced that no serious obstacles prevented building a ship canal and, considering the diminutive proportions of vessels at that period, the enterprise was well within the engineering capacity of the 16th century. It was proposed to employ native slave labor in its construction. Political and strategic considerations prevented the Spanish government from ever encouraging the enterprise. When Mexico became independent it was too much engaged in restoring order to give attention to internal improvements and it was not until 1842 that a concession for opening a line of communication by canal or railway, or both, was granted to Don Jose de Garay, a citizen of that country. Accurate surveys were made and a practicable route selected, but, for lack of financial encouragement, the concession was afterward surrendered. Until 1852 capitalists of the United States betrayed no special interest in the enterprise, but when the permanent development of California and Oregon was assured, the importance of more rapid communication between the East and West was quickly realized. In that year the Barnard and Williams expedition was dispatched to the isthmus to survey a route for an inter-oceanic railway. These explorers made very careful surveys of the entire route and pronounced the enterprise perfectly feasible, but were subsequently ordered out of the country, the introduction of American capital not being encouraged by the Mexican government, so soon after the war between the two countries. In 1871 the expedition under Commodore Shufeldt was dispatched to the isthmus by the United States government to make a final survey and finally determine whether a ship canal could be built over the route or not. The result of the survey was a decision that a ship canal, capacious enough for modern vessels, was not practicable owing to insufficient water supply for the upper levels. This expedition also reported adversely to the lagoons, which indent the western coast and were considered the natural location for a terminal harbor, on account of certain unfavorable physical conditions there existing. A new location for a terminal was chosen at Salina Cruz, a few miles westward of the mouth of Tehuantepec River, where greater depth of water was afforded, as well as more complete shelter from the prevailing winds.

Henceforward all projects for building a ship canal over the Isthmus of Tehuantepec were abandoned, but the Mexican government readily granted concession after concession to parties, mostly Americans, to construct railways; but owing to powerful influences every attempt was frustrated and the liberal grants suffered to lapse or were withdrawn.

The Eads Ship Railway.— In 1883 James B. Eads, a distinguished engineer, conceived a plan for the construction of a railway over the isthmus by which vessels of the largest dimensions could be transported by rail at a speed of 10 miles an hour. The details contemplated the deepening of the Coatzacoalcos River for a distance of 20 miles to the town of Minatitlan, which was to be the eastern terminus. The western terminus was to be at Salina Cruz. At these points giant pontoon docks were to be located and three lines of railway of standard gauge connected the two points. As a vessel sailed into the pontoons it rested upon a railway carriage, secured from all strain by ingeniously contrived supports. Raised to the level of the tracks the carriage was connected to three powerful locomotives and with its load carried across the isthmus and deposited into the sea at the other terminal. The length of the railway was to be 165 miles, with a very substantial roadbed and with not greater than 20-mile curves. Where abrupt curves existed, they were to be avoided by turntables at five different points. Vessels in transit were thus always in a straight line. The plan after being subjected to much criticism was at last endorsed by the highest engineering authority in the world and would probably have been built but for the death of its projector in 1887. Its cost was estimated at $75,000,000. Mexico granted 1,000,000 acres of public land in its aid. Thus for three and a half centuries every plan conceived for the attainment of communication over the isthmus having failed, Mexico determined upon the construction of the railway as a national work and spent $20,000,000. Finally about 1907 the railway was opened to a length of 192 miles, but the impending opening of the Panama Canal greatly reduced its importance.

TEIXEIRA DE MATTOS, tā-shā'rä dä mät'tōs, **Alexander Louis**, English journalist and translator: b. Amsterdam, Holland, 9 April 1865. He settled in England in 1874, was educated at Beaumont College, Old Windsor, and entered journalism. He has been engaged as correspondent and as associate editor on various periodicals and has published translations of Melati van Java's 'Resident's Daughter' Zola's 'Curée'; 'Memoirs of Chateaubriand' and of the plays: Zola's 'Thérèse'; Josine Holland's 'Leida'; 'The Cradle' (from the Flemish) and some of Maeterlinck's tales.

TEJU, or **TEGUEXIN**, a large lizard (*Tupinambis teguexin*), inhabiting tropical America. The upper parts are deep-black, mottled with green and yellow; the sides show two rows of white spots; and the under parts are yellow, marked with black stripes. A full-grown specimen may be three feet in length, mostly tail. These lizards frequent forests and plantations, are carnivorous and their strength and speed enable them to catch a great variety of animals, including barnyard chickens and eggs. They are consequently hunted, not only as pests, but because they are themselves good to eat. They dwell in burrows, lay hard-shelled eggs in the ground and defend themselves by vigorous lashing of the tail. Their general resemblance to the Egyptian *Varanus* gives them the borrowed name «salvator» in some places. This lizard represents an American family, the *Tejidæ*, with long forked tongues largely covered with scale-like papillæ. The teeth are solid and implanted almost on the edge of the jaw and are therefore intermediate between acrodont and pleurodont. The body is covered with small scales (osteoderms are absent) or the skin may be simply granular above; the under surface is covered with larger scales, generally arranged in transverse rows. «This large family,» says Gadow, «which comprises nearly 40 genera with more than 100 species, exhibits great diversity of form. Some are inhabitants of forests and are arboreal, while others are strictly terrestrial, preferring hot and sandy plains, or they dwell below the surface and are transformed into almost limbless and blindworm-shaped creatures.» Representatives of the family are spread from Texas and Utah to the borders of Patagonia.

TEKELI, tĕk'ĕ-lĭ, or **TOKOLY**, tė'kėl-yĭ, **Emmerich**, Count of, Hungarian noble: b. about the middle of the 17th century; d. Nicomedia, Asia Minor, 1705. His father had headed an insurrectionary movement against Austria and he himself was chosen by the Hungarians in 1678 their commander-in-chief. He broke into Upper Hungary, captured several fortresses and towns, devastated Moravia and penetrated into Upper Austria. The emperor consented to redress several grievances at the Diet of Oedenburg (1681); but the insurgents were not satisfied and refused to lay down their arms. Tekeli now put himself under the protection of the Sultan Mohammed IV, by whom he was declared king of Hungary. A war between the emperor and the Porte ensued in which the Turks advanced (1683) as far as Vienna, but were totally defeated before that city by John Sobieski, king of Poland (12 Sept. 1683). The count continued the war, but without success. He fell under the suspicion of the

Turks, who sent him a prisoner to Adrianople (1685). Meanwhile his wife was besieged by the Austrians in the castle of Munkács, where she held out for three years, until she was compelled by famine to surrender (January 1688). The Turks discovered the groundlessness of their suspicions of Tekeli and he once more received the support of the sultan, who designated him prince of Transylvania. He penetrated into that country and routed the imperial general (1690); but in the same year he was compelled by Louis, margrave of Baden, to retire. He continued in all the struggles between Austria and Turkey till 1697, when the Peace of Carlovitz was concluded, in which Turkey renounced the cause of the Hungarians. Tekeli then retired to the dominions of the sultan, who conferred upon him several estates, with the title of prince of Widdin.

TEL EL AMARNA. See Tell el Amarna.

TEL EL KEBIR. See Tell el Kebir.

TELAUTOGRAPH, an instrument for the instantaneous transmission of a facsimile copy of writing or pen drawing. Telautograph was the name given by Elisha Gray, who invented the apparatus to his particular form, but it has been extended to cover varieties of machines having the same purpose. In Gray's apparatus the transmitting pen is connected by silk cords to mechanism by means of which the motions of the pen cause a pulsatory current to pass into two telegraph wires. These pulsatory currents produce rapid pulsatory motion of the armature of a system of electro-magnets by means of which the receiving pen is caused to follow the motions of the transmitter. Another electro-magnetic arrangement lifts the receiving pen off of the paper at the end of each line, while still another moves the paper forward to receive the next line from the pen. As commonly used a pencil is employed instead of a pen for transmitting and a continuous roll of paper is provided at both the transmitter and receiver. The writer or sender of the message pulls a little lever to shift his paper and the motion is conveyed electrically to the paper roll at the receiver. The receiving pen is a capillary glass tube at the junction of two light metal arms. This glass fountain pencil repeats automatically all the movements of the sending pencil, so that either words, pictures or signs are accurately duplicated. This apparatus can be used on the same wires as a telephone without disturbing the use of the latter, does not require an operator at the receiving end, and interception of the message by wire tapping is impossible.

In a modified form of telautograph known as the telechirograph, invented by Gruhn, a radically different receiving apparatus is used. The transmitted currents influence two electro-magnets which in turn cause a small concave mirror to move; a light ray from a small incandescent lamp falls upon the mirror whence it is reflected to a sheet of sensitized paper. The mirror is attached by means of cement to a small iron plate in the form of a triangle, one corner of which rests upon a set screw upon which the mirror can oscillate. Beneath the two other corners extend two armatures subjected to the attraction of the electro-magnets. These armatures undergo oscillations corresponding to the component movements of the transmitting pencil; they are carried by flat springs, and the oscillations are given to the iron plate and, of course, to the mirror fastened to it. Before the message can be delivered the receiving sheet must be developed; the apparatus for this is simple: when the message is completed a small electric motor operated by an independent battery in the receiving room is set in motion; this motor works a train of wheels or rollers which draw the portion of the film written upon by the light ray through a developing bath and out again through a pair of rubber drying rolls. The completed message is delivered in less than 35 seconds after the transmitting operator has placed his pencil in its rest.

TELECHIROGRAPH. See Telautograph.

TELEDU, a badger (*Mydaus meliceps*) of Java, which is skunk-like in its habits, and in the copious and far-reaching vileness of the secretion in its anal glands.

TELEGONY, the inheritance by offspring of the characteristics of some previous mate of one or both parents. That such inheritances existed was long the belief of breeders of live-stock, who spoke of the phenomenon as «throwing back.» Until about 1890 scientific men generally lent their support to this theory, although Weismann long ago expressed serious doubts. About 1895 Ewart began a series of careful experiments at Penicuik, near Edinburgh, Scotland, and certain others were undertaken in Germany and Brazil, the outcome of which was to show that the phenomena noticed were evidences of atavism, or reversion or variation, and that no such a thing as telegony existed. See Heredity.

TELEGRAPH BATTALIONS. The general duty of signal troops is to collect and transmit information, to assist in providing security for troops, to assist in directing fire attack during combat, to provide means for ready verbal and written communication between distant commanders and troop leaders, to facilitate the transmission of verbal and written messages and orders, to insure the secrecy of such messages when necessary by means of codes and ciphers, to exercise supervision over the character of matter transmitted by means under its control, and when circumstances make it neccessary, to fight in order to accomplish any of these objects.

The work of signal troops assigned to lines of information in war varies with the nature of the lines which they control, viz. (1) The maintenance and operation of electrical lines of information from the capital of the nation to the headquarters of the armies in the field. (2) The construction, maintenance and operation of the radio stations and central permanent telegraph and telephone lines connecting the headquarters of each army in the field with its various divisions and other units, and the necessary camp telephone and telegraph lines within these armies. These lines are included in the zone of the advance.

The signal organizations assigned to both these classes of duties are called *Telegraph Battalions*. In the first class they are distributed along the lines and at stations as required for construction, maintenance and operation without being supplied with the special technical equipment and transportation required in the field. They operate the telegraph cable and radio offices and the telephone systems with substantially the same apparatus used in times of peace. These lines extend from the seat of government through the zone of the line of communications up to army headquarters. For maintenance, repair and extension the material and equipment supplied is the same as in commercial practice.

In the second class of work signal troops must instal and operate lines under quite different conditions. The poles and wire must be light and the instruments of special design for a service unlike that encountered in commercial practice. For administrative purposes the telegraph battalions employed in this class of work are organized into companies, and these in turn into sections, each equipped with supplies and transportation for installation of a complete telegraph or telephone system in the mobile units with which they serve. The telegraph battalion prescribed in the tables of organization consists of two companies. Each company has six sections — three telegraph and three telephone. A telegraph section is equipped to instal 20 miles of wire on lances with three telegraph offices. The equipment is carried in one wagon of the escort type and one lance truck. The 10 men of the section furnish the linemen, operators and messengers necessary for the construction, maintenance and operation of 20 miles of line. The telegraph equipment and personnel of the company is sufficient for 60 miles of line and that of the battalion for 120 miles. A telephone section is supplied with material for the installation of a telephone system of 20 telephones connected with a field switchboard and 20 miles of insulated wire laid on the ground or supported on lance poles. The equipment is carried in two telephone wagons of the escort type and the lance truck. Twenty-one men make up the switchboard operators, linemen and messengers needed. The equipment of the telegraph battalion is necessarily bulky and heavy and its mobility in general is limited to that of the supply train.

TELEGRAPHONE, a recording telephone, the invention of Valdemar Poulsen, of Copenhagen. He devised a magnet of sufficient delicacy to limit the magnetizing of a metal plate to the direct point of contact, no matter how minute that point might be. His magnet, in tracing its course over a steel disc, magnetizes only the molecules of the steel with which it comes into direct contact. Thus localized and defined, electro-magnetism becomes controllable. The result was a mechanism that recorded the sounds given into a telephone receiver, on discs that could be mailed like letters, and reproduced by the recipient. This interesting machine failed of commercial success. Consult *Scientific American* Sup. (Vol. LXIII, No. 1625, 23 Feb. 1907).

TELEGRAPHY. The word telegraph is derived from the Greek, *tele*, «afar off,» and *graph*, «to write.» In the modern practice of telegraphy, however, the term has a wider meaning and is used to signify any means by which intelligence is transmitted to a distance by signs or sounds. In this sense the word would also include the transmission of speech electrically to a distance, but inasmuch as that highly important art possesses its own appellation (telephony) such a use of the word is unnecessary.

From remotest times methods of communicating intelligence to a distance have been employed for purposes of war and defense. The Greeks were perhaps the first to adopt systematic methods of telegraphing, and a description of a telegraph system that was employed 300 B.C. is to be found in the writings of the Greek General Polybius.

Polybius Telegraph.— The operation of this system was as follows: At each station there were two walls about seven feet in length and about six feet in height, separated by a space of three feet. At night one or more torches, as desired, but not exceeding five in all, were placed on top of the walls, and certain combinations of the torches represented the letters of the Greek alphabet. A tablet showing the combinations of torches for the various letters was provided at each station. For instance, two torches on the right-hand wall and three on the left wall would represent the letter H. Five torches on the right wall and four on the left, Y, and so on. When it was desired to signal a station, two torches were set on a wall, which signal was answered by a similar arrangement of torches at the other station. The operator then proceeded to spell out his message by placing the torches in the required combinations, one letter at a time. The tablet mentioned was divided into five vertical and five horizontal rows of squares, each letter of the alphabet being allotted a certain square, beginning at the upper left-hand corner with A, and running horizontally across the tablet. Any letter could thus be found by giving the number of vertical and horizontal rows at the intersection of which was the square allotted to that letter. For instance, the letter Y would be at the intersection of the fourth horizontal and the fifth vertical rows. The code thus formed, in a more or less modified form, is in use to-day by the military departments of various countries as a means of telegraphing maps of a locality.

Fire and Smoke Signals.— The use of fires by night and smoke by day has long been practised by even the most uncivilized races, as a means of communicating intelligence to a distance. In numerous places in this country there still remain evidences of this practice by the aborigines, in the shape of mounds on hill tops and other points of advantage, on which the accumulated ashes of beacon fires of bygone years may be found beneath the roots of trees of gigantic size. In the country between Chillicothe and Columbus, Ohio, for instance, may be traced over 20 such mounds, so related to one another that if all the trees were removed fire signals might be transmitted from one end of the valley to the other in a few minutes. To this day the Indians of North America practise this method of signaling the approach of enemies in their territory; and up to within a comparatively short time beacon fires were the most favored methods of signaling the approach of an enemy in Great Britain and other parts of Europe.

Semaphore Systems.— It was not until the end of the 18th century that any comprehensive plan of signaling was employed in Europe or in this country. The plan then introduced was that known as the Chappé semaphore system of signaling. This semaphore resembled the semaphore so common on all railways to-day, consisting of an upright post, on the top of which movable arms or blades are pivoted, but in the Chappé semaphore the arms were arranged quite differently from those of the ordinary railroad device. Thus the crossarm on the top of the post was 14 feet in length, and at each end of this arm a shorter arm was pivoted at right angles to the longer arm. By a system of ropes and pulleys these arms could be manipulated by the operator and placed in many different positions, certain positions of the arms representing given letters of the alphabet. Hence by appropriately placing the arms, the manipulator could spell out words and messages which an operator at a distant station could read and, if necessary, retransmit to another station further on. These semaphores were placed on substantial stone towers at distances apart ranging from six to 10 miles, and their use spread rapidly throughout Europe. In France, Germany and Russia especially the system was widely used. For example, a string of 220 semaphore towers, extending from the Prussian frontier to Petrograd, via Warsaw, a distance of over 1,200 miles, and employing over 1,300 operators was erected at great expense. In Prussia also a line of semaphore stations from Berlin to Treves, via Potsdam, Magdeburg, Cologne and Coblenz, was established in 1832, at a cost of 170,000 thalers. In France there was a semaphore line from Paris to Toulon, 475 miles apart, and requiring 120 stations.

The transmission of signals by semaphore systems was necessarily slow (about one signal per minute), inasmuch as each signal was verified by the receiving station before another was transmitted. The time taken in transmitting a signal or letter from Paris to Toulon was, however, comparatively speedy, namely, 10 to 12 minutes.

Semaphore signaling is still usefully employed in some countries for communicating from ship to shore, between coast-guard stations, at rifle ranges, etc. One plan of this kind consists in the use of two small flags, one held in each hand. The flags are about 18 inches square, the staff is about three feet in length. The letters of the alphabet are represented by the positions in which the flags or the arms are held. With the aid of a telescope, signals may be transmitted by this method to a distance of three miles in fair weather. Messages may also be read by the use of the arms alone, employing the same alphabet, in which case this is termed the human semaphore.

Electric Telegraph Systems.—Although up to 1852 a number of visual systems of telegraphy, such as the semaphore system, were, as stated, in quite extensive use, electricity had been utilized experimentally long prior to that date for purposes of telegraphy but its growth in this direction was slow and the scepticism with which its commercial utility was at first regarded is evidenced by the extensive establishment of semaphore stations, just mentioned, long after the possibility of electric telegraphy had been more or less clearly indicated.

In 1774, Lesage of Geneva constructed an electric telegraph system which employed in its operation 24 line wires, one for each letter of the alphabet. At the terminal of each wire pith balls were suitably suspended, and, taking advantage of the well-known repellant effect that follows the similar electrification of such light substances, Lesage, by the use of frictional electricity applied to the wires, transmitted intelligible signals over them. In 1815 Francis Ronalds of England improved on this arrangement. A revolving dial, operated by clock-work, was employed at each end of a wire. The dials rotated synchronously. A notch was cut in each dial, behind which the letters of the alphabet were placed in a circle, so that as the dial revolved one letter at a time was seen through the notch. Pith balls were electrically connected at each end of the wire. At a given signal the dials were set in rotation and as the notch arrived at a desired letter the pith balls were actuated electrically. The letter was noted and in that way messages were transmitted. In 1774 Volta had discovered that electricity could be generated by means of the "voltaic" battery, and availing of the current from such a battery efforts were made, with more or less success, between the years 1806 and 1830, to utilize the electrolytic property of an electric current to decompose chemical solutions at the distant end of a wire to indicate telegraph signals. These experiments were the precursors of others more successful in the line of electrochemical telegraph systems of later years, and to which further reference will be made herein.

Needle Telegraph Systems.—Availing of Oersted's discovery that a pivoted magnetic needle is deflected from its normal position, parallel to a wire, when an electric current passes in that wire needle telegraph systems came into existence and were extensively employed in Europe at one time and are yet in use there. For this purpose a magnetic needle is pivoted in the centre of a coil of wire, and a pointer suitably attached to the needle, swings in front of a dial. The needle and with it the pointer can be deflected to the right or left by changing the direction of the current through the coil. Certain deflections of the needle to the right or left, or combinations of deflections to the right and left represent the letters of the alphabet, and these deflections are produced by sending over the wire current pulsations in positive or negative direction, or alterations of both, as required by the letter to be transmitted. For instance, if the Morse alphabet were used, a motion to the right would represent a dot; one to the left a dash. The alterations of polarity are transmitted by a "drop-handle" or a "tapper." The tapper is similar to the double-sending key used in submarine telegraphy. (See Fig. 15). A needle system employing two needles has also been used. This required two wires, but gives a higher rate of speed — about 15 to 20 words per minute. The operator reads incoming signals by observing the movements of the needle or needles.

Bright's Bell.—A modification of the needle telegraph is that known as "Bright's Bell," in which two bells of different tone are struck by a hammer, one tone representing, for instance, a dot; the other, a dash. In other instances, the needle of the needle system is caused to strike metal tubes of different tones, one tone indicating a deflection in one direction, the other tone a deflection in the opposite direction. These have been termed acoustic telegraphs.

Electric Chemical Telegraphs.— See *Automatic Telegraph Systems* in this article.

Morse Electro-Magnetic Telegraph.— In 1824 Sturgeon of England discovered that when a current of electricity is caused to flow in an insulated coil of wire, surrounding a bar of soft iron (that is, well-annealed iron), the bar takes on magnetic properties, and when the current ceases to flow in the coil the iron at once loses its magnetism. Employing these electromagnetic phenomena, Morse, in 1837, invented the telegraph system which bears his name, and which to-day is in extensive use in one form or another in every part of the world. It was then known that when a piece of soft iron is placed near a magnet there is a mutual magnetic attraction which tends to draw them together. This fact is also availed of in the Morse telegraph system as will be shown in the case of the Morse relay and sounder.

To obtain the flow of current in the coil of wire required to magnetize the iron bar, the circuit must be complete, and a source of electromotive force must be provided.

An electric «circuit» may be represented, as in Fig. 1, by a line or wire, *W;* battery, *B,* the

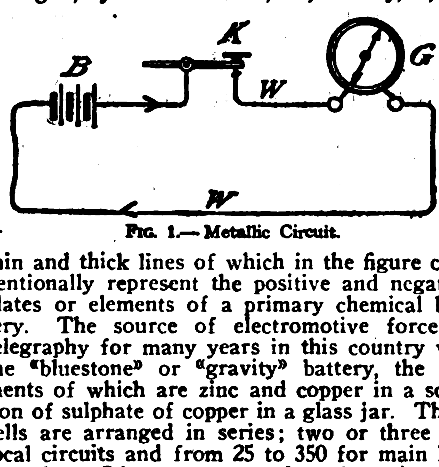


Fig. 1.— Metallic Circuit.

thin and thick lines of which in the figure conventionally represent the positive and negative plates or elements of a primary chemical battery. The source of electromotive force in telegraphy for many years in this country was the «bluestone» or «gravity» battery, the elements of which are zinc and copper in a solution of sulphate of copper in a glass jar. These cells are arranged in series; two or three for local circuits and from 25 to 350 for main line batteries. Of recent years these batteries and the bichromate primary batteries employed in Europe, have given way largely to storage batteries and dynamo machines as a source of electromotive force.

When dynamos are employed they are in some cases designed to develop about 70 volts each. Several of these machines are connected in series so that by tapping the machines at different points an electromotive force of 70, 140, 210 volts, etc., may be obtained. In other cases dynamos developing 70, 140, 300 volts, respectively, are employed. Two sets of such machines are provided, one set to furnish positive polarity, the other negative polarity, inasmuch as it is essential in the practice of telegraphy to utilize currents of opposite direction or polarity; instances of which will be noted in connection with the descriptions of duplex and quadruplex telegraphy in this article.

Reverting to Fig. 1, *G* is a galvanometer, an instrument to indicate the presence of an electric current in a circuit, and which is constructed on the principle of the indicating needle of needle telegraph systems previously mentioned. The direction of the current in the circuit is assumed to be from the positive pole of the battery *B* to the galvanometer *G,* and back to the negative pole of the battery. The key *K* affords a ready means of «opening» and «closing,» or of «making» and «breaking» the circuit. When the key is closed, or down, the circuit is complete and current flows; when the key is «open» or up, the circuit is open or broken, and no current flows therein. An ordinary telegraph circuit without instruments is indicated in Fig. 2. This is termed a ground

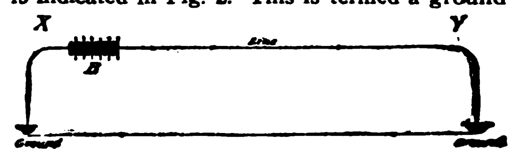


Fig. 2.— Ground Return Circuit.

return circuit. A circuit like that indicated in Fig. 1 is termed a «round» or metallic circuit. In the case of a ground return circuit the earth acts virtually as though it were a wire of inappreciable electrical resistance, completing the circuit from end to end.

In the Morse telegraph system signals are transmitted electrically from one station to another by the opening and closing of the circuit, or wire, by means of the key, for short and long intervals, which acts operate the Morse relay and sounder or register, and cause them to produce sounds or printed characters corresponding to dots and dashes of what is known as the Morse telegraph alphabet.

In Fig. 3 is shown theoretically the essential apparatus of a Morse telegraph equipment at two terminal stations, *X, Y. B* is the battery; *K* is the Morse key. *S* is an iron core or bar, arranged in the shape of a horseshoe, around which a coil of fine wire is wound. *A* is a small piece of iron, termed the «armature,» which is mounted on a

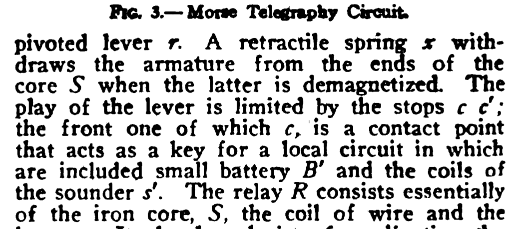


Fig. 3.— Morse Telegraphy Circuit.

pivoted lever *r.* A retractile spring *x* withdraws the armature from the ends of the core *S* when the latter is demagnetized. The play of the lever is limited by the stops *c c';* the front one of which *c,* is a contact point that acts as a key for a local circuit in which are included small battery *B'* and the coils of the sounder *s'.* The relay *R* consists essentially of the iron core, *S,* the coil of wire and the lever *r.* It also has devices for adjusting the position of the armature relative to the ends of the core, and screw posts for facilitating the connections of the wires leading into and out of the instrument. (See Fig. 5).

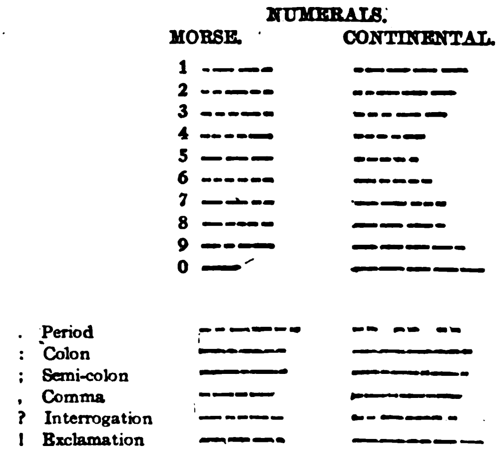
The object in using the sounder s' in Morse telegraphy is to obtain louder sound than is practicable with the Morse relay. The magnetism developed in a given electro-magnet, such as a relay or sounder, increases with the strength of current, also with the number of convolutions of wire in the coils, within certain limits. In fact, up to the point of magnetic saturation of the iron, the resulting magnetism is directly proportional to the product of the current strength in amperes by the number of convolutions, or turns, of wire; which product is termed the «ampere turns.» Saturation is, however, seldom or never reached in the magnets used in telegraphy. Again, with a given electromotive force the current strength is inversely proportional to the resistance of the circuit, and as the resistance of a wire of given diameter increases directly with its length, the longer the wire, the weaker will be the current. It is found that to produce the clear, loud click of the ordinary Morse sounder, about .25 ampere is required, while a main line relay will operate freely with .040 ampere (40 milliamperes). To operate a sounder placed in a main line having 1,200 ohms resistance would require an electromotive force of about 300 volts. It is, therefore, more economical and in other ways better to employ a lower electromotive force, about 60 volts in this case, and a relay having many turns of finer wire than the sounder (about No. 30 B & S gauge) and a light armature, not designed to produce a large volume of sound, which relay by means of its armature lever and a «logical» battery is then caused to operate a sounder as indicated in Fig. 1.

The sounder is constructed on the same principles as the relay, but the wire with which it is wound is larger, about No. 24 B & S gauge, and its armature and lever are heavier. Since the lever r of the relay controls the local circuit of the sounder it follows that as the main line is closed and opened, thereby closing and opening the relay, the local circuit will be similarly closed and opened, by which actions the electromagnet of the sounder will be correspondingly alternately magnetized and demagnetized, and the armature lever will be attracted by the magnetism and withdrawn by its retractile spring. The motions of the sounder thus produced cause the long and short sounds which are translated into letters of the alphabet by an expert operator. When a Morse register or ink recorder is used in place of the sounder these dots and dashes are embossed or printed on strips of paper from which the message may then be transcribed by any one familiar with the dot and dash code. Plainly many more relays may be placed in the main circuit than are shown in Fig. 3. It is not uncommon in this country to have 30 or 40 relays in one Morse telegraph line, and with but two main batteries, one at each end. When any one of the keys of a Morse telegraph circuit is open none of the remaining keys can close the circuit, and when any one key is operated all the relays on the same wire will be operated concurrently, by reason of the opening and closing of the circuit by that key. Any attempt to operate two keys at once on this circuit results in the clashing of signals. Such circuits are termed «single» or «simplex,» inasmuch as but one message at a time can be sent over them. This fact distinguishes simplex from multiplex circuits over which two or more messages can be transmitted simultaneously, instances of which will be given herein.

The arrangement of Morse circuits just described is termed the «closed circuit» method of operation, from the fact that the circuit is normally closed with current on the line. In Europe the Morse circuits have generally been operated on what is termed the «open circuit» plan, which consists in so arranging the apparatus that the battery shall only be placed to the line when a message is to be transmitted; at other times the battery is disconnected from the line. For this purpose a key with front and back contacts is used, similar to K in Fig. 12; battery being placed as there shown, and the receiving instrument being placed in the circuit of the back contact at x in that figure. In the open circuit method battery is necessary at every station.

Telegraph Alphabets.— The American Morse code or alphabet which is in general use on overland Morse telegraph lines in the United States and Canada is composed of dots and dashes and of combinations of dots, dashes and spaces. Letters made up partly of spaces are termed «spaced» letters. The letters C and R are instances of spaced letters. (See illustration below). Dots, dashes and spaces are formed by the length of time during which the key or other transmitting instrument may be held closed or open; the

LETTERS.	MORSE.	CONTINENTAL.
A	· —	· —
Ä		· — · —
Á or Å		· — — · —
B	— · · ·	— · · ·
C	· · ·	— · — ·
Ch		— — — —
D	— · ·	— · ·
E	·	·
F	· — ·	· · — ·
G	— — ·	— — ·
H	· · · ·	· · · ·
I	· ·	· ·
J	— · — ·	· — — —
K	— · —	— · —
L	⸺	· — · ·
M	— —	— —
N	— ·	— ·
Ñ		— — · — —
O	· ·	— — —
Ö		— — — ·
P	· · · · ·	· — — ·
Q	· · — ·	— — · —
R	· · ·	· — ·
S	· · ·	· · ·
T	—	—
U	· · —	· · —
Ü		· · — —
V	· · · —	· · · —
W	· — —	· — —
X	· — · ·	— · · —
Y	· · · ·	— · — —
Z	· · · ·	— — · ·
&	· · · ·	



time of making a dot being taken as one, or one "time unit." In length or duration a dash is theoretically equal to three time units. The space between the elements of a non-spaced letter is equal to one time unit; the space between letters of a word is equal to three time units; the space between words, to five time units; the interval in spaced letters is equal to three time units. The object of the framers of this alphabet in utilizing spaces in some of the letters was to minimize the length of the letters and thus practically to increase the speed of transmission by this alphabet. It was found, however, in automatic telegraphy that the use of spaced letters increased the liability to errors, and hence an alphabet, known as the Continental or Universal Code, was adopted in Europe in which spaced letters are not used. This alphabet is now employed universally in Morse telegraphy outside of the United States and Canada. The American Morse and Continental Morse alphabets or codes are given on preceding page.

Morse Telegraph Apparatus Manual Transmitting Keys —As previously intimated, the characters of the Morse alphabet are formed by the manipulation of a suitable key. The key originally employed by Morse was a cumbersome piece of apparatus. The key now employed in the United States could not well be made lighter. Its construction will readily be grasped by reference to Fig. 4. A steel

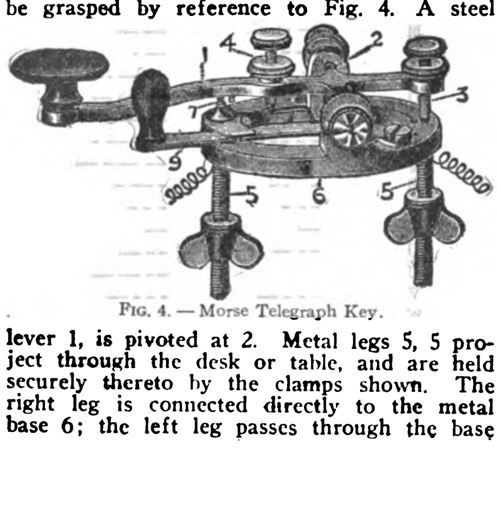


FIG. 4. — Morse Telegraph Key.

lever 1, is pivoted at 2. Metal legs 5, 5 project through the desk or table, and are held securely thereto by the clamps shown. The right leg is connected directly to the metal base 6; the left leg passes through the base and is insulated therefrom by a hard-rubber bushing. On its top there is a cone-shaped cap, termed the anvil, carrying a small platinum contact point, 7. A small strip of metal extends out from the cap. At a point on its under side, directly above the contact 7, the lever 1 is provided with a platinum contact 8, termed the hammer. A curved strip of metal 9, the "circuit closer," is pivoted on the base 6. When the circuit closer is pushed under the strip projecting from the cap 7, it closes the circuit, regardless of the opening between the anvil and the hammer. The lever 1 and the circuit closer 9 are supplied with hard-rubber finger tips, or knobs, by which they may be handled freely without danger of shocks. A spring adjustable by a set screw 4, normally lifts the lever 1 from the anvil. When the operator is about to "send," the circuit closer must be first pushed out from 7 so that the lever when operated may open and close the circuit; for it will be seen that when the hammer is brought into contact with the anvil the circuit is closed at that point. Platinum is employed at all important contacts because of its durability and freedom from oxidation due to the sparking which usually occurs when electric circuits are broken. The manually operated Morse keys employed in Great Britain and Europe are practically similar to that shown here, but they are larger and heavier.

Morse Telegraph Relay.— The electro-magnet which Morse first employed in telegraphy weighed over 300 pounds. In 1844, however, the weight of this instrument had been reduced to 185 pounds. Within 15 years from that time many improvements had been made in the instrument and it then weighed but little more than the modern main-line relay (typified in Fig. 5), about three pounds. As late as 1867 relays were wound to 1,100 ohms; the present standard resistance of this instrument is about 150 ohms. In the case of what are termed "low resistance" relays the coils are wound to 37.5 ohms. These relays are utilized in a number of instances where many relays are employed on one circuit, as on railway telegraph lines and the total reduction of resistance brought about by their use is found to effect a very beneficial result in the operation of the circuits in wet and foggy weather. The obvious explanation of this result is that, since the electric current seeks the path of least resistance, the lower the resistance of the wire circuit the less will be the tendency of the current to escape by the "leaks" to ground, where foliage, trees, etc., touch the wire.

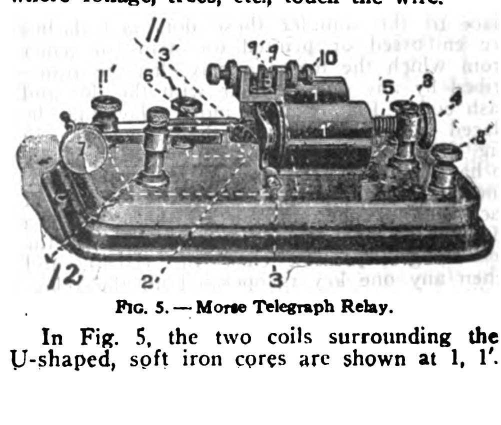


FIG. 5. — Morse Telegraph Relay.

In Fig. 5, the two coils surrounding the U-shaped, soft iron cores are shown at 1, 1'.

These coils are covered by hard rubber sleeves. The armature 2 in this type of relay is a part of the iron lever 9'. These relays are adjusted in two ways; either by drawing the cores away from the armature by means of the screw 4, or by means of the retractile spring 6 attached to the armature, the tension of which is variable by the winding device 7. This winding screw is movable toward or from the relay coils by aid of the post 12 through which the supporting piece of 7 passes. The main line wires are connected to the screw posts 8, 8', from which small wires lead to the coil 1, 1'. The local, or sounder, circuit wires are brought to screw posts 11', 11, from which posts wires lead to the armature lever 2, and to the front contact 10. The object of the relay being to repeat or relay the signals passing on the main line to the sounder, the play of the armature lever (which latter is pivoted at 3, 3'), should not be large. This play is regulated by the front stop screw, that is, the stop next the coils, and by the back stop screw, which is insulated.

Telegraph Sounder.— Many different styles of sounders are in use. A well-known form is illustrated in Fig. 6. In this *B, B* are the

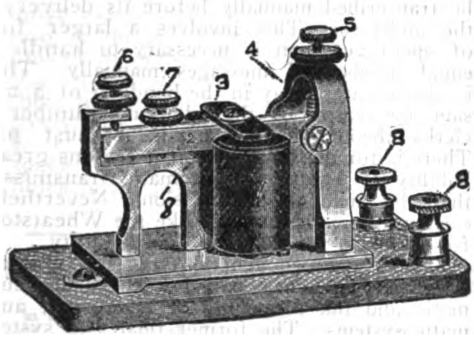


Fig. 6. — Morse Telegraph Sounder.

binding posts; 1 represents the electromagnets; 2 the lever, pivoted on the support 4; a spring adjustable by the screw 5 gives the left end of the lever a tendency to rest on the upper stop 6. Magnetism in the cores draws the armature down, and with it, the lever, until the stop 7 meets the metal support 8. The base is designed to give resonant effects. When used on primary battery circuits these sounders are wound to 4 ohms: when employed on dynamo circuits they are often wound to 20 and 40 ohms.

Telegraph Transmitters.— With the object of obtaining a simple and speedier method of transmitting the characters of his alphabet than the manually operated key method, Morse devised several mechanical arrangements. One of these consisted of a plate of ebonite or wood on the surface of which were placed in a vertical row short and long strips of metal, corresponding to the letters of his alphabet. These strips were all metallically connected under the plate by a wire which led to the battery, relay and ground. The line wire was connected by an insulated wire to a metal stylus. This stylus was held in the hand of the operator and in transmitting a message he would run the point of the stylus over the metal strips representing the given letters, thereby closing and opening the circuit, in a manner corresponding to the manual transmission of the letter. Another somewhat similar device, also due to Morse, consisted of a metal cylinder on the surface of which the characters of the Morse alphabet were arranged in a practically similar way. A keyboard was arranged over this cylinder and the depression of a key brought a metal brush into contact with the cylinder. At the same time the cylinder was caused to make a partial revolution. The characters on the cylinder being connected to the line, and the brush to the earth, the foregoing described actions resulted in the transmission of Morse characters. These transmitters did not go into wide use at that time, but within the past four or five years a keyboard transmitter, termed the "Yetman" transmitter, which is a much improved form of the Morse cylinder transmitter, has been largely adopted by telegraph operators in this country. The employment of this device was no doubt encouraged by the recent employment by operators of the typewriters as a means of transcribing received messages, which gave the receiving operator an advantage over the sending operator who could only send from 30 to 40 words per minute at best speed. By means of the keyboard transmitter a speed of transmission approaching the speed of transcription by the typewriter is obtained. This use of the typewriter was accompanied by a new arrangement of the sounder, which is now placed in a box, or resonator, mounted on an adjustable rod that brings the sounder in close proximity to the ear of the operator.

Lightning Arresters.— Lightning discharges tend to follow telegraph wires into cables across rivers, and into the telegraph offices, causing damage to the cables and instruments. Damage is sometimes caused also by the contact of telegraph wires with electric light and power wires. To prevent as far as possible damage from these causes, lightning arresters and fuses are placed at points just outside of cables and at points where the wires enter offices. A combination lightning arrester and

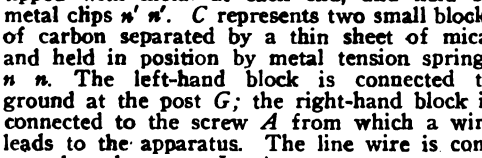


Fig. 7. — Lightning Arrester and Fuse Wire.

fuse wire is shown in Fig. 7. *F* is a small fuse wire carried on a strip of mica *m* which is tipped with metal at each end, and held by metal clips *n' n'*. *C* represents two small blocks of carbon separated by a thin sheet of mica, and held in position by metal tension springs *n n*. The left-hand block is connected to ground at the post *G;* the right-hand block is connected to the screw *A* from which a wire leads to the apparatus. The line wire is connected to the screw *L*. A strong current passing through the fine wire *F* will fuse it; a lightning discharge will jump to ground by way of the carbon blocks; in either case protecting the cable or instruments.

Automatic Telegraph Repeaters.— The function of a Morse automatic repeater is to take, as it were, the message from one wire and "relay" it to another wire without the intervention of an operator. Some of the reasons that render repeaters necessary are, first, that the resistance of the wire increases directly with its length, which tends to a diminution of current strength; second, the escape of current from the line wire at points where it makes contact with trees is greater on a wire of high resistance than one of low resistance (see RELAYS); third, the speed of signaling decreases as the electrostatic capacity is increased and this capacity increases with the length of the wire. Hence it is found desirable in practice to limit the direct length of a telegraph circuit to a maximum of about 500 miles in this country.

The apparatus and circuits of an automatic telegraph repeater at an intermediate station are outlined theoretically in Fig. 8. This is

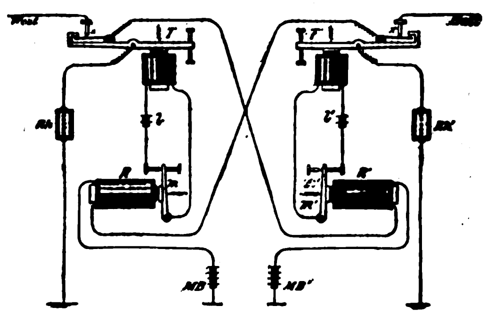


FIG. 8.—The Toye Repeater.

known as the "Toye" repeater, which was at one time much in use, and is chosen for illustration because of its comparative simplicity. It may be noticed that relay *R* controls the "continuity preserving" transmitter *T* by means of its armature lever *m*, and local battery *b*; while relay *R′* controls *T′* by means of lever *m′* and battery *b′*. Also that transmitter *T* controls the western main circuit at *x*; while *T′* controls the eastern circuit at *x′*. In practice *T′* is the "opposite" transmitter to relay *R*, and *T* is the "opposite" transmitter to *R′*. In the operation of an automatic repeater the desideratum is automatically to keep the "opposite" transmitter passive while its circuit is being repeated into, in shop phrase. The operation of the Toye repeater is as follows: Assume that the East is sending to the West. When the eastern operator opens his key, thereby opening the eastern circuit, relay *R* opens, as in the figure. This opens transmitter *T*, and in consequence the western circuit is opened at *x*. At the instant, however, that the western circuit is opened at *x*, the circuit which includes the relay *R′* and main battery *MB′* is closed via the lever of *T*, through a resistance *Rh* equal to that of the eastern circuit. As this transposition or substitution of circuits maintains the current passing through relay *R′* at the same strength as before the change of circuits was made that relay, and, consequently, the transmitter *T′* remains closed. In this way the "opposite" transmitter is automatically kept passive. When the eastern operator again closes his key, relay *R*, and in turn *T*, are likewise closed, resulting in the closing of the western circuit at *x*. When the West sends to the East the described actions are reversed.

Among the other automatic repeaters now in use may be mentioned, the Milliken, the Neilson, the Weiny, the Maver-Gardanier, the Atkinson, the Ghegan and the Varley.

Automatic Telegraph Systems.—Automatic telegraphy consists of arrangements of apparatus whereby Morse characters are transmitted at a rate of speed ranging from 80 to 2,000 or 3,000 words per minute. As the rate of speed by hand transmission of Morse characters is from, say, 15 to 40 words per minute, it is obvious that by the use of a rapid automatic system many more messages may be transmitted over one wire in a given time than by the manual method; and since the cost of construction and maintenance of the wires is a large portion of the expense of a telegraph equipment, if everything else were equal, the advantage would be largely in favor of the automatic systems. But, as frequently happens, everything else is not equal. In the first place, every message sent by an automatic Morse system has to be manually prepared for transmission by the automatic machinery, and every message received must be transcribed manually before its delivery to the addressee. This involves a larger force of operatives than is necessary to handle an equal number of messages manually. There is also greater delay in the handling of a message by reason of the additional number of clerks through whose hands it must pass. There is for the same and other reasons greater liability to errors by automatic transmission than by manual transmission. Nevertheless certain automatic systems, like the Wheatstone, for instance, are found of much utility.

There are two general types of automatic telegraph systems, namely, chemical automatic and ink recording, or embossing, automatic systems. The former relates to systems in which electrochemical action produces the records of the signals, the latter to systems in which, as the term implies, the signals are recorded by ink recorders.

Chemical Automatic Telegraphs.—At one time in Europe and in the United States chemical automatic telegraph systems were largely employed in commercial telegraphy, but at the present time its use is confined almost exclusively to recording signals in police, fire alarm and similar systems. (See ELECTRIC SIGNALING). The message for transmission by chemical telegraphy is usually prepared by perforating, in a paper strip, holes corresponding to the characters of the Morse alphabet. This strip is then drawn over a metal roller on which rests a steel needle or brush; the needles and the roller being made a part of the circuit in which there is a primary battery or other suitable source of electromotive force. As the paper is drawn along, the needle, or brush, drops into the holes in the paper, making contact with the roller and completing the circuit. In this way current pulsations corresponding in duration to dots and dashes are sent over the wire. At the receiving station there is a practically similar arrangement, except that the perforated paper is not used, but, instead, a strip of paper that has been immersed in a chemical solution is drawn over a roller.

Wheatstone Automatic Telegraph — This is an ink recording system. Its apparatus consists of a *perforating machine* by which messages are prepared for transmission; a *transmitter* which utilizes the perforated paper to transmit messages thus prepared, and a *receiver* which, being actuated by the electrical pulsations set up by the transmitter, records them in ink, on stiff paper tape, as dots and dashes. The *perforator* consists of small hollow cylinders with keen edges, in close proximity to which the paper to be perforated is caused to pass. Three discs, connected with these cylinders and representing the dot, dash and space, are depressed by the stroke of a mallet in the hands of an operator, with the result that holes of a certain order are punched in the paper. Thus when the dot disc is depressed, three vertical holes are cut; when the dash disc is depressed two vertical and two horizontal holes are cut, and when the space disc is depressed one central hole is cut, virtually as shown at the left of Fig. 9. The *transmitter* in its operation takes the place of the operator's hand and formulates dots and dashes with an accuracy superior to and at a speed 10 to 15 times greater than the most expert operator can attain. That portion of the transmitter apparatus actually employed in transmitting signals is outlined in Fig. 9. *L' L* are vertical rods attached at their lower ends to crank-levers *A' A*, respectively. By means of adjusting screws *F, F, L'* is set to the left of *L* a distance equal to the space between any two horizontal central holes in the paper. The crank-levers are provided with horizontal connecting rods *H, H'*, the right ends of which pass through holes in a centrally pivoted lever *M* and through supporting sleeves *x x*. *H, H'* are provided with collets *C, C'* which at certain times alternately engage with ends *P' D* of lever *M* and push them over. The springs *s s'* give the rods *L L'* a constant tendency upward, but their upward motion is checked by the pins *R' R* on the rocking beam *V*, which by suitable mechanism within the box on which the apparatus is supported is given a rocking motion. When the right end of the beam moves upward the spring *s'* causes rod *L* to follow pin *R*, and at the same time the connecting rod *H* pushes the strip *P'* on *M* against the upper contact 2 on a metal strip *N*; while concurrently the end *D* of *M* is brought into contact with the lower contact 3 on a metal strip *P*. The positive pole of a battery *B* is brought to strip *P*, the negative pole to strip *N*. The "ground" is connected with the lower

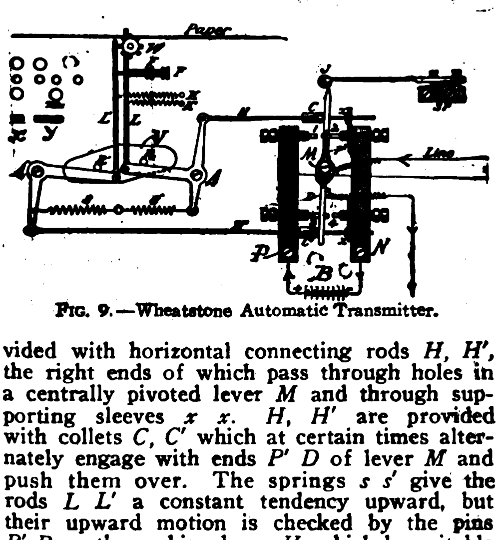


FIG. 9.—Wheatstone Automatic Transmitter.

end *D* of *M*; the line wire to the upper end *P'*; *D* and *P'* being insulated from one another. The lever *M* is really a pole-changing key and the rods and levers simply displace the operator's fingers, causing that key to reverse the poles of the battery. In the present position of *M* in the figure the negative pole of the battery is placed to the line. The perforated paper is shown by a single line and the rod *L* has passed through a hole in the paper. A revolving star-wheel *W* meshes with the central rows of holes in the paper and draws it along at a uniform rate of speed. Assuming there is another hole in the paper immediately opposite that one through which *L* has just passed, when the lever *L'* moves upward it will pass through that hole, the paper having been moved forward by the star-wheel just enough to bring the hole opposite *L'*. At the same time, by the downward motion of *L* the collet *C* has been withdrawn, giving collet *C'* on *H'* free scope to push *D* against its right contact, 4, and *P'* against the contact 1 which it will be seen reverses the polarity of the battery to line. If a succession of dot holes were punched on the paper, a succession of short positive and negative currents would pass over the line. When, however, a set of diagonal holes, as at *Y* in Fig. 9, is punched on the paper, the result is different, for at the first upward movement of *L* it will pass through the hole, pushing end *P'* of *M* to the right, but at the following upward movement of *L'* it meets the paper at a point opposite the hole through which *L* had just passed and its further upward motion is arrested. Hence *M* is not pushed over and the battery is not reversed. At the next upward movement of *L* its motion is similarly arrested and the polarity of the battery is still unchanged, until at the next upward movement of *L'* it comes opposite and passes through the hole *M*, causing the collet *C'* to push *D* against contact 4, thereby reversing the poles of the battery to line. This delay in the reversal of the battery is sufficient to make an appreciable difference in the length of the signal recorded, and constitutes a dash. The effect of these different actions is that, depending on the position of the perforations in the paper strip, dots and dashes are transmitted by the pole-changer *M*.

The Wheatstone automatic receiver, or ink recorder, consists of a polarized relay (see *Polar Duplex* in this article), the armature lever of which is extended at a right angle at its upper end, and this extension at certain times is caused to impinge against a light rod pivoted at one end. On the end of this rod is a small circular disc, the lower portion of whose periphery is immersed in an ink well; an upper portion of its periphery is placed very near the stiff paper tape previously mentioned. The axle of this disc is given a slight tension away from the paper. When, however, a current of positive polarity, designed to record a dot or dash on the paper, actuates the polarized relay, its extended armature lever presses against the axle of the disc causing it to deposit a mark on the moving paper tape. A negative current causes the withdrawal of the disc from the paper. The positive current in this system is termed a "marking" current; the negative current a "spacing" current, when it is operated by the «double current» or reversal of polarity method; to which further reference will be made in connection with *Duplex Telegraphy*, also in this article. The circular disc is kept in rotation by simple clockwork mechanism and thus constantly renews its supply of ink. The paper strip is drawn forward at a desired rate by rollers operated by mechanism within the box.

The Wheatstone automatic telegraph may be worked duplex by using a differentially wound relay and the other necessary apparatus of a duplex system. When worked as a duplex it gives a wire of moderate length, in which there are no very long submarine or underground cables, a capacity of from 200 to 350 words in each direction. On a 1,000-mile duplex circuit, such as from New York to Chicago, with one repeater station at Buffalo, a speed of about 125 words per minute in each direction is now obtainable.

Writing Telegraph Systems.— Writing or automatic telegraph systems transmit and record facsimiles of letters or characters while they are being formed by the stylus or pen in the hand of the operator. The first to produce a writing telegraph system was probably Mr. A. E. Cowper, of England, who employed in the operation of his system the principle of the parallelogram of forces, whereby by compounding the movements of a point in two directions, the one at an angle to the other, the actual movement of the point is the resultant of the two movements. The Telautograph (q.v.) also operates on this principle. In the Cowper system the receiving pen depends for its movements upon variations of the magnetism of two electromagnets placed at right angles to one another, which variations produce changes in their magnetic fields, to which changes an armature carrying the receiving pen is free to respond. The magnets are placed in separate circuits. The variations in the magnetic strength of the magnets are caused by variations of the current strength in their circuits, which variations are brought about by means of a pencil which when moved by the operator in the act of writing is caused to switch resistance coils in and out of the respective circuits.

Duplex Telegraphy.— This consists in the sending of two messages over one wire in opposite directions at the same time. Since on an ordinary Morse telegraph circuit it is not possible to send more than one message at a time over a wire, it is essential, in order to make duplex telegraphy possible, that the signals transmitted from the sending station shall not interfere with the signals to be received at that station. The receiving instruments must, therefore, be so constructed or so placed that while ready to respond to all signals from the distant station they shall not respond to signals from the near or home station. These requirements are met in two ways in practice; one method being known as the «differential,» the other as the «bridge» method. The differential plan is used almost exclusively on land line duplex telegraphy; the bridge plan is utilized exclusively on long submarine cable telegraphy. The «differential» plan avails of the fact that if a soft iron bar or core, *B* Fig. 10, be wound with two coils of wire — oppositely wound as shown — a current from a battery *b* will flow in opposite directions around

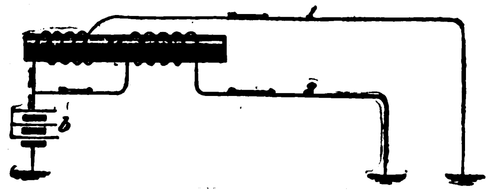


FIG. 10.—Theory of Differential Method.

the iron bar, and as each current tends to set up opposite magnetic poles in the iron, one current will neutralize the other and no magnetic effects will be produced in the core. If, however, another battery or source of electromotive force should be placed in the circuit of wire 1 at its distant or right-hand end, a greater amount of current will flow in coil 1 than in coil 2, and in consequence the core will be magnetized to a degree depending on the difference in the strength of currents flowing in the respective coils; hence the term differential, and a relay wound in this way is termed a differential relay. The theory of the «bridge» plan is outlined in Fig. 11. The battery, and

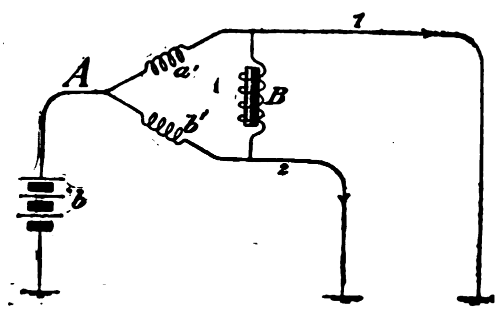


FIG. 11.—Theory of Bridge Duplex.

wires 1 and 2 remain as before, but the iron bar *B* is now connected between them and is wound with but one coil. *a′*, *b′* are coils of resistance, termed the arms of the «bridge» (Wheatstone bridge). Assuming the resistance of wires *a′*, *b′* and wires 1 and 2 to be equal, the electric pressure due to battery *b*, at the terminals of the bridge wire, will be equal and opposite, and hence no current will flow in the bridge wire.

There are two systems of duplex telegraphy in use in this country and elsewhere, namely, the «Stearns» duplex and the «Polar» duplex, and these combined comprise the Edison «Quadruplex,» described later.

The Stearns Duplex.— The Stearns duplex is operated by increment and decrement of current on the line, virtually as the single Morse system is operated, namely, by sending a current over the line to actuate the distant relay, which attracts its armature; and by removing the current from the line, whereupon the armature is withdrawn by its retractile spring. The near or home battery is prevented from affecting the near relay by winding the relays differentially. The theory of the Stearns duplex is shown in Fig. 12, which represents the apparatus at two stations, *A* and *B*. The relays *M, M'*, are wound with two coils in opposite directions around the cores; one of the coils of each relay being connected to the main line and the other to a rheostat, or resistance coils, *R, R'*. *K* and *K'* are transmitting keys. When key *K* is closed it puts a positive electromotive force to the line; when key *K'* is closed it puts a negative electromotive force to the line. When the keys are «open» the line wire is placed to ground. Since the battery current will divide between the two coils of the relay in proportion to the resistance of the circuits attached to each coil, a means must be provided to make those circuits of equal resistance, otherwise unequal currents will flow through the coils and the relays will be operated by the home battery. It is the function of the rheostats *R* to provide a resistance equal to that of the main line and the main line coil 1, of the distant relay, so that there will be a «balance.» In the figure, key *K* being closed and key *K'* open, a current flows as indicated by the arrows from *A* to *B*. As equal currents are flowing in opposite directions around the core of relay *M* its armature is not attracted. On the other hand, as there is a direct path for the current at *B* to earth, via the back contact of key *K'*, no current from *A* will flow through coil 2 of relay *M'*. Consequently, the core of *M'* is magnetized

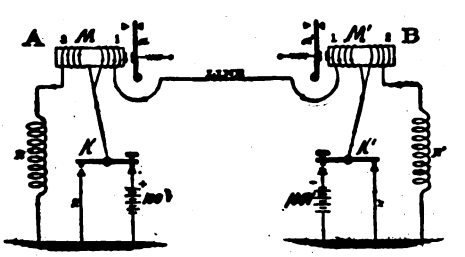


FIG. 12.—Theory of Stearns Duplex.

and attracts its armature *a'* as shown. If now key *K'* should be closed this would add 100 volts negative polarity to the main line circuit, making 200 volts on the main line, while it would place only 100 volts to the artificial line coil at *B*. Hence double the amount of current will flow in the line coils 1, of each relay, that flows through the artificial line coils 1 and 2. Thus the armature *a'* of *M'* is now attracted and armature *a* of *M* continues to be attracted.

The Polar Duplex.— This system also employs differential wound relays, transmitting keys and main and artificial lines similar to those of the Stearns duplex and for the same purposes, but the type of transmitting keys and relays is different in the two systems.

The relay employed in this system is termed a polarized relay (*E, E'*, Fig. 13) and is based on the fact that unlike magnetic poles attract one another, and that like poles repel one another. Then if one pole of a bar permanent magnet *a*, say its north pole *N*, be so pivoted that it may move freely toward the south pole *s* of an electromagnet *E*, it will follow that by changing the direction of the current flowing in the coils of the electromagnet, the permanent magnet *a* will oscillate between the poles in response to the changes of polarity in the electromagnet. If the permanent magnet *a*, which is virtually the armature of a polarized relay, be given control of a local circuit containing a sounder *D* and battery *b*, it may be caused to record signals in a manner practically similar to that in which the Stearns'

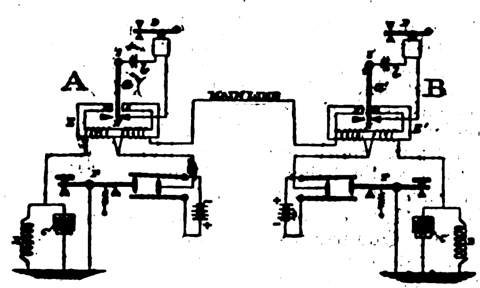


FIG. 13.—Theory of Polar Duplex.

relay records them. It is only necessary to provide a pole-changing key *F F'* to reverse the direction of the current flowing in the line, to bring about this result. Fig. 13 represents in theory the circuits and apparatus of a differential polar duplex; the apparatus and arrangement of circuits at the terminal stations *A* and *B* being indicated. When the «pole-changer» *F* is «closed» as at *A*, a positive pole of a battery is placed to the line and the direction of the current is as indicated by the arrows. When the key *F'* at *B* is closed, a negative pole of a battery is placed to the line. In these positions of the keys the direction of the currents in the main and artificial lines is as shown by the arrows, and the relays at both ends of the line are recording a signal, the sounders being attracted. This is due to the fact that an excess of current is flowing in the line coils of each relay in a direction to produce magnetic poles in the cores of the relays as marked. If now, for instance, the key *F'* at *B* should be opened the effect would be to place a positive pole of the battery to the line. The effect of this is that each end of the main line is placed at equal and like potentials, and hence no current flows over the main line or in the main line coils of the relays. A positive current from the battery at *A* with a strength of say 1 will still flow through artificial line coil at *A*, but in a direction which will reverse the previous polarity of the core; consequently the armature *a* of the relay is attracted to the left side and the local circuit of sounder *D* is opened. An examination of the conditions will show in every case that when the pole-changer at either end is opened or closed, the local circuits controlled by the armature of the distant relays will also be «opened» or «closed.» From which it follows that dots and dashes may be transmitted from both ends of the line simultaneously by a proper manipulation of the pole changers.

The instrument *C C'* shown at *A* and *B* is an electrical condenser. It performs a very useful function in duplex and quadruplex telegraphy as follows. The artificial line coils R R which are used to "balance" with are usually composed of spools of fine German silver wire, wound double, or non-inductively, so that they may not possess any perceptible magnetic effect or inductance. These coils have no static capacity. The main line it is known does possess static capacity. Hence at the moment of charging and discharging the line there is a momentary inrush and outrush of current into and from the line greater than that due to the ohmic resistance of the line. This would produce a momentary inequality in the current in the coils of the relays unless equal capacity were given to the artificial line. This is done by adding the condensers C C' to the artificial line. These condensers are adjustable and by means of metal plugs more or less capacity may be added until a static balance is obtained. The rheostats are also adjustable in order that the resistance balance may be readily obtained.

The Quadruplex (Edison).— The Stearns duplex depends for its operation upon the increase or decrease of the strength of current on the line, regardless of the direction (polarity) of the current, whilst the polar duplex depends upon changes in the direction of the current regardless of current strength. In the operation of the Edison quadruplex system both of these principles are combined on one wire; the instruments used being the transmitting key (transmitter) and Morse relay (the neutral relay) of the Stearns duplex, and the pole-changer and polarized relay of the polar duplex.

The relays are wound differentially for the purpose stated previously and rheostats, condensers, etc., are employed, as in the duplex systems described. In the Stearns duplex, when the transmitter is open there is no electromotive force to the line, the wire in that case being placed directly to ground. Since the polar duplex depends for its operation upon the reversal of polarity, provision is made for this requirement in the quadruplex by so arranging the connections of the transmitter K that when the latter is "open" a small portion, 1, of battery B is left in the circuit to be operated by the pole-changer PC. When K is closed, the full battery B is reversed by the

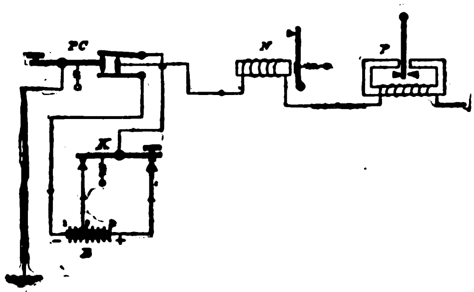


Fig. 14.—Theory of Edison Quadruplex.

pole-changer. On the other hand, when the small portion 1 of battery B is to the line, and only a weak current is traversing the line, the adjustment of the retractile spring is such that the armature a is withdrawn from the core; while, when the key K is closed, and the full strength of battery passes to line, the armature is attracted. Both stations are similarly equipped. Thus an operator may manipulate key K and the consequent increase and decrease in the current strength will operate the distant neutral relay N. But the operation of key K will not practically affect the distant polarized relay P, inasmuch as that key does not alter the direction of current on the line. On the other hand the pole-changer PC will operate the distant polarized relay, but will not operate the distant neutral relay. Thus two messages may be sent in opposite directions at once over a quadruplex circuit; this system, therefore, giving the equivalent of four wires from one. The three wires thus gained are termed "phantom" wires.

Many details of apparatus required in practice are, for lack of space, omitted here, but complete details of these systems are given in the author's 'American Telegraphy and Encyclopedia of the Telegraph,' from which work a number of the diagrams used in this article are reproduced with the consent of the publishers.

Submarine Cable Telegraphy.— The speed of signaling through an electrical conductor is inversely proportional to the product of its electrostatic capacity and the resistance. The capacity and resistance of a conductor increases directly with its length. The capacity also varies with the material comprising the insulating medium (see Electric Condenser). The high electrostatic capacity and the great length of submarine cables conduce to slow signaling. When a long cable is connected with a source of electromotive force the charge is communicated to the distant end almost immediately, but the amount of charge at first arriving is extremely small and the charge or current rises slowly thereafter to its maximum. The discharge is approximately as gradual as the charge. Hence a desideratum in submarine telegraphy is a receiving instrument that will respond to a very feeble current, for the weaker the current required the shorter will be the time of charging and discharging the cable, and the more rapid will be the rate of signaling. The first most successful receiving instrument devised for this work was the Thomson mirror galvanometer (see Galvanometer). The light from a lamp is thrown upon the mirror and the light is reflected back upon a screen. The mirror is carried on a suspension system including several very small magnetic needles, which are in the centre of a coil of fine wire, the coil being in the circuit of the cable. Minute pulsations of current cause the needles to be deflected to the right or left according to the direction of the currents. This causes the spot of light on the screen to be deflected to the right or left. A deflection to the right constitutes a dash, one to the left a dot. The direction of the deflections is regulated by a special form of key (K, Fig. 15) at the sending end (a tapper) by means of which positive and negative currents may be transmitted. The mirror receiver gives no record of the message, the signals being written down by the operator as they are received.

A later invention, the Siphon recorder, also due to Sir Wm. Thomson (Lord Kelvin) overcomes this objection. This instrument, outlined in Fig. 15, consists of a coil of fine copper wire, A, which is suspended between the poles of a powerful magnet, M, in such a manner that when a current passes through the coil it, like the needles in the mirror galvanometer, tends to place itself at right angles to the lines of force of the magnetic field. When no current is flowing in the coil, two small weights, w, suspended from the lower end of the coil, hold it in the plane of the magnetic lines of force of the magnet. A siphon C consisting of a very small glass tube is attached to the coil

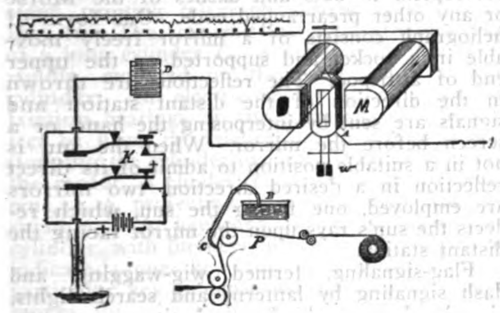


FIG. 15.—Theory of Submarine Cable Telegraphy.

by a fine wire. The lower and bent end of the siphon is placed directly over the centre, or imaginary zero, of a paper ribbon P. The double pole-changing key K sets up momentary pulsations of positive and negative currents through the coil the movements of which cause the lower end of the siphon to move to one side or other of the zero line of the paper. The upper end of the siphon dips in an ink-well B and, by an ingenious electrical arrangement, not shown in the figure, the ink is caused to spurt out at the lower end of the siphon upon the paper strip as a succession of very fine dots. Thus it is not needful that the siphon should touch the paper and in this way friction is avoided. A specimen of the signals as recorded by the siphon recorder is shown at the top of the figure.

For reasons not well known the earth's electric potential varies at different parts of the earth. Hence there is usually a difference of potential between the terminals of a long cable. This would tend to produce a current in a sensitive receiving instrument, which would deflect it to the detriment of signaling. To avoid this difficulty a condenser p is placed between the cable and the earth. This, so to speak, breaks the continuity of the circuit for slow changes of potential. When the condenser is once charged with the earth's potential, current ceases to flow into the cable and the receiving instrument comes to zero. The changes in the earth's potential occur comparatively slowly — from maximum positive to negative in perhaps five minutes. Consequently these changes are scarcely perceptible on the receiving instrument. The quick changes of potential due to the transmitter, however, produce currents of charge and discharge that operate that instrument.

Long submarine cables are usually duplexed, the «bridge» method of preventing the effect of the home transmitting key upon the home receiving instruments, being employed. An artificial cable consisting of strips of tin foil arranged to give resistance and capacity equal to the actual cable is employed instead of the rheostats and condenser used for the artificial line in overland duplex telegraphy.

Signals are now usually transmitted over long submarine cables by automatic transmitters somewhat similar to the Wheatstone transmitter; the messages being perforated in advance on a strip of paper. A speed of about 40 words per minute in each direction is reached on some of the newer Atlantic cables.

Simultaneous Telegraphy and Telephony. — This is sometimes erroneously termed «composite telegraphy.» The art relates to telegraphing and telephoning over one wire at the one time.

When a telephone receiver is inserted in an ordinary telegraph circuit the operation of the Morse keys deflects the diaphragm abruptly and produces loud noises in the telephone which render the reception of speech nearly impossible. Van Rysselberghe, of Belgium, discovered that if the rise and fall of the telegraph currents were made gradual no disturbing sounds would be heard in the telephone. To bring about this result he introduced into the telegraph circuit a combination of electromagnets and condensers, which by retarding the rise and prolonging the fall of the telegraph currents merely inflect the diaphragm of the telephone, but do not produce any sound thereby. When this result is obtained the telephone currents may then be superposed upon the telegraph currents without impairing the efficiency of the telegraph signals. Simultaneous telegraphy and telephony is now in successful use in the United States on a large scale; two telegraph circuits being operated as one telephone metallic (two wire) circuit, on circuits up to 400 miles in length.

Synchronous Multiplex Telegraphy.— It is known that 500 pulsations of electricity per second can be transmitted on an overhead wire of moderate length. A telegraph operator at his best speed is not capable of transmitting more than an average of 10 dots per second. Hence it was thought that if means were devised whereby a number of operators should consecutively be given exclusive control of a wire for brief intervals of time the same wire might be utilized to transmit four, six or more messages at practically the same time. In order that this might be done satisfactorily it was evident that the corresponding transmitting and receiving instruments at the near and distant stations should be placed in connection with the wire at identical instants. This entailed the construction of devices for obtaining exact synchronism; hence the name of the system.

The apparatus for obtaining synchronism and for apportioning the wire among a number of operators consists of a revolving wheel at each end of the telegraph line, the wheels revolving as nearly as possible at a uniform rate. Each wheel is driven by an electric motor whose motion is controlled by a vibrating reed at each station, which reeds are attuned to the same rate of vibration, as closely as possible. This wheel is supported on a vertical shaft. Below it is a stationary circular disc made up chiefly of a large number of metal segments (84) radiating from near the centre of the disc, and insulated from one another by suitable material. The shaft supporting the wheel passes through the centre of the disc. The shaft carries by a suitable projection a brush or trailer, which, as the wheel revolves, is swept over the segments in rapid succession. As the trailer makes three revolutions per second it comes in contact with each segment three times per second. If it is desired to transmit six messages at once, 72 segments are set apart for the purpose, and each of six desks at each end of the wire are allotted 12 segments. That is, starting from any given point on the disc, the first segment will be given to desk No. 1; the second segment to desk No. 2, and so on to the sixth segment, where two segments are skipped, being reserved for synchronizing purposes. A second series of six segments is then connected to desks Nos. 1, 2, 3, and so on around the disc. The line wire is connected to the shaft or trailer of the revolving wheel at each station, and, consequently, as the trailers make three revolutions per second, each desk of the six is placed in contact with the line, and with its corresponding desk at the distant station, 36 times per second. As an operator cannot make a dot in less than the one-twelfth of a second it follows that in that time the trailer will have given him contact with the line thrice. Hence each one of six operators may transmit messages as though he had entire control of the line. As each character received at any one desk is formed of a number of pulsations an arrangement of relays with a contact on the «back-stop» is employed which delivers the signals virtually unbroken at the receiving end. Synchronism is maintained by means of the two segments referred to which send «correcting» impulses that retard or accelerate the speed of the wheel that carries the trailer.

Dial Telegraphs.— Variously known as dial, A, B, C, and pointer telegraph system; due to Breguet, Kramer, Frischen, Wheatstone and Siemens-Halske. These systems employ a dial carrying on an outer circle the letters of the alphabet and on an inner circle figures and punctuation marks. A pointer operated by suitable mechanism within a case moves like the minute hand of a clock around the dial in response to pulsations of electricity from a sending instrument. The sending instrument has a similar dial and is equipped with a key which is movable around the face of the dial. As the key is thus moved it opens or closes a circuit, or it causes the movement of a magnet before coils of wire within the case, that transmits pulsations of electricity over the line, which in turn actuate, by means of an electromagnet, an escape wheel that moves the pointer as stated. The operator moves the transmitting key uniformly around the dial. As he does so the pointer on the receiving instrument moves a corresponding distance. When the key arrives at a desired letter the operator pauses. The receiving operator or attendant notes the letter; the sender moves his key to the next desired letter, and so on, in this manner spelling out his message. This system is slow, but it possesses the advantage of requiring little or no skill on the part of the user for its operation. Hence, especially before the days of the telephone, it was in favor as a means of communication between police and fire headquarters, on railroads, etc. As elsewhere stated telegraphs of this order are still in use in other countries.

Military and Naval Telegraph.— Heliography is quite extensively employed by the army and navy of this and other countries. The distance covered between any two stations is about 25 miles. Signals are transmitted by reflections of the rays of the sun, the duration of the reflections being made to correspond to dots and dashes of the Morse or any other prearranged code. One form of heliograph consists of a mirror freely movable in a socket and supported on the upper end of a tripod. The reflections are thrown in the direction of the distant station and signals are sent by interposing the hand or a screen before the mirror. When the sun is not in a suitable position to admit of its direct reflection in a desired direction, two mirrors are employed, one facing the sun, which reflects the sun's rays upon the mirror facing the distant station.

Flag-signaling, termed wig-wagging and flash signaling by lanterns and search lights, also by horns, whistles and sirens are employed by the various armies and navies of the world. Also Morse telegraphy and wireless telegraphy (q.v.). Torches at night take the place of the flag in signaling. In flag and torch signaling, as well as in heliography and lantern signaling the Continental Morse alphabet is now used. Arbitrary characters of this general type have long been used in needle telegraph systems in which a deflection to the left is represented by the figure «1»; a deflection to the right by the figure «3.» Thus A would be represented by «33» in one such alphabet, or two deflections to the right.

In wigwagging or torch signaling the flagman faces exactly toward the distant station; staff is vertical in front of centre of body, but at height of waist. When the Morse alphabet is employed, a dot is represented by a motion of flag or torch to right; the dash, a motion to the left; the space by a «front» motion. See SEMAPHORE.

Printing Telegraphy, Stock Tickers.— Printing telegraphy relates to those telegraph systems in which telegrams are printed as received on strips or sheets of paper. Generally speaking, printing telegraph systems of the stock ticker type depend for their operation upon the synchronous rotation of a wheel or cylinder at a receiving station with a typewheel at a receiving station. If, for example, two wheels of equal size having on their peripheries type letters of the alphabet are placed side by side and are caused to rotate, it is obvious that if they start with a similar letter at a given point, each wheel will continue to present a similar letter at the given point as long as the wheels rotate at equal speeds. It is, however, a difficult matter to obtain a continuous synchronous rotation of two or more such wheels or cylinders, especially when they are revolving at a high rate of speed, unless their movements are under control of some master wheel or transmitter. Consequently, in electrical printing telegraphy, controlling devices of this nature are employed. For instance, in the well-known «ticker» systems, the type-wheels of the tickers in the various offices are placed under control of a transmitter which maintains them in synchronism by a «step-by-step» movement, so called. In certain other printing telegraph systems, such as the Hughes, largely used in Europe, the uniform rotation of the transmitting and receiving wheels is maintained by a nearly synchronous rotation of the motors at each end of the circuit, and, in addition, by a «correcting» device applied to the type-wheel. See *Synchronous Multiplex Telegraph* in this article.

A theoretical diagram of a simple «step-by-step» printing telegraph system is shown in Fig. 16. The transmitting apparatus consists of a long cylinder *T*. A metal segmental *W* is rigidly mounted on the same shaft as the cylinder. An electric motor is mounted by friction bearings on the same shaft. The object of using the friction bearings is to permit stopping the cylinder instantly, without stopping the motor. Cylinder *T* carries a set of blunt pins, *p*, *p*, projecting in a spiral row from its surface. A keyboard is placed above the cylinder, with the keys directly over the pins as indicated; one key for each pin. When a particular key is depressed, its spur, or catch, moves into the path of a corresponding pin,

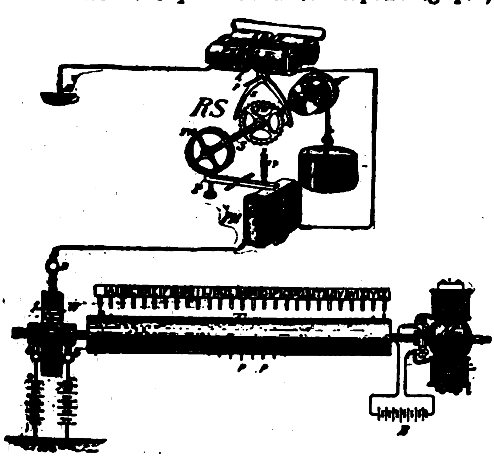


FIG. 16.—Theory of "Ticker" Telegraph.

thereby instantly arresting the cylinder. The wheel *W* is insulated in two parts or segments as indicated by the zig-zag line *i*. As the wheel rotates, portions of the respective segments (*s*, *s'*) alternately pass under brush *B*, with the result that momentary currents pass alternately from positive and negative batteries *b*, *b'*, giving the equivalent of an alternating current on the line.

The receiving apparatus or «ticker» proper, *RS*, consists of a polarized relay *PR* (see section *Polar Duplex*); an electromagnet, termed the «press» magnet *PM*; a typewheel *TW*, and an escape-wheel *EW*. A drum *D* by its weight *F* tends to rotate the shaft *S* on which *TW* and *EW* are mounted. The escape E is connected rigidly with an armature *A* of *PR*, and is pivoted at *P*. Relays *PM* and *PR* are in the same circuit, as shown. The line pulsations are of sufficient strength to oscillate rapidly the armature of the polarized relay, in consequence of which the escapement *E* allows the escape wheel and type-wheel to revolve rapidly. Owing to the greater inertia of the press magnet lever it does not respond to these rapid pulsations of current. When, however, the cylinder *T* is brought to rest, the steady current operates *PM* and its lever is sharply attracted and prints a letter.

Assuming that the wheel *W* sends out 32 electrical pulsations in one revolution these pulsations will cause one revolution of the type-wheel. Thus, if the transmitter be set in motion with brush *B* resting on the segment that is in line with, say, the pin under key *A;* while the letter *A* on the type-wheel is opposite the platen *P* on the end of the lever of the press-magnet, it follows that for every revolution, or part of a revolution, of the cylinder just enough pulsations will be transmitted to cause the type-wheel to present a letter opposite the platen corresponding to the key depressed. If the transmitter and type-wheel do not start with corresponding letters in the required position misprints follow. This is obviated by devices which bring the apparatus to a «unison» point after a few revolutions of the cylinder. The speed of rotation of this apparatus is about 120 revolutions per minute.

The apparatus shown prints letters only. When figures are to be printed, a figure wheel is placed on the shaft, side by side with the letter wheel, and a «shifting» device is employed which shifts the letter or figure wheel under the printing platen when a letter or figure is to be printed. Usually two wires are employed in the latter case, one to operate the «shift» apparatus.

In printing telegraph systems of the kind just mentioned, considerable loss of time ensues from the fact that frequently it is necessary to rotate the type-wheel the greater part of a revolution in order to print one letter. Thus, if the letter A follows B in a given word, it will require 31 pulsations of current to print A, assuming that there are 32 letters and punctuation marks on the type-wheel. If R follows C, 15 pulsations will be necessary. This conduces to a low rate of speed, perhaps an average of 30 to 40 words per minute; the message being printed on a paper strip.

Hughes' Printing Telegraph.—An understanding of the operation of this system may be gathered in a general way from the immediately preceding remarks. It is not, however, a step-by-step system, but depends for its operation on the synchronous rotation of two wheels, one at each end. When a key of the keyboard is depressed at the sending station it catches a pin on a rotating wheel, or *chariot*, but does not stop the wheel. The pin so caught, however, at that instant causes the transmission of an electric current over the line. This pulsation in turn instantly operates an electromagnet at the receiving end which trips a device that throws the paper strip against the letter on a type-wheel which at that moment is in the printing position, and, assuming the transmitting and receiving apparatus to be in synchronism, a letter corresponding to the key depressed will be printed at the receiving station. The synchronous rotation of the wheels is obtained primarily by means of a pendulum at each station which is adjusted and arranged to ensure a proximate rate of rotation to the respective wheels, but as the pendulums alone cannot be depended upon to maintain proper synchronism, a cam arrangement is provided which, every time a letter is printed, moves into a receptacle on the edge of the printing wheel and corrects the synchronism of the wheel, putting the wheel slightly forward or backward, as may be necessary. Pulsations of current are thus only transmitted over the line when a letter is to be printed.

Buckingham Page Printer.— To avoid the loss of time due to the rotation of a single type-wheel with many characters the Buckingham printer (in one of its forms) employs four very small octagonal type-wheels mounted side by side on one shaft. On the periphery of each wheel eight letters and other characters are placed, 32 in all. The shaft on which these type-wheels are mounted is so arranged that by an ingenious disposition of five electro-mechanically operated levers, it may be given both a lateral and a rotary motion such that any one of the 32 characters on the type-wheels may be placed before a given point for printing, by five pulsations of current. The selection and printing of any letter or punctuation mark are brought about by a cycle of six pulsations of current in all — that is, three alternations of

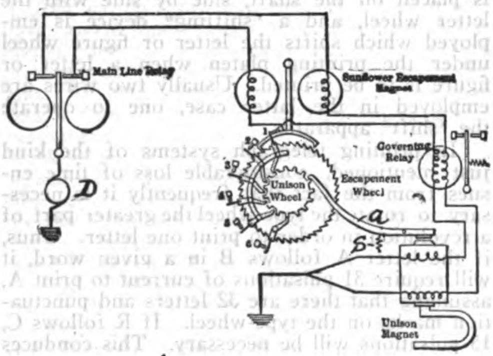


FIG. 17.—Buckingham Printing Telegraph.

polarity. These pulsations are of varying length, akin in this respect to the Morse alphabet. For example, the letter A will be selected by a dash, short space, dot, short space, dot; B by a dot, long space, dash, long space, dot, dots and dashes being made by positive currents, spaces by negative currents, as in the Wheatstone automatic telegraph (q.v.). The combinations of dots, dashes and spaces representing the different letters comprise what is known as the Buckingham alphabet. For the actual printing of a character the sixth pulse, corresponding to the space between letters and words in the Morse and Wheatstone systems, is utilized. This is always a negative pulsation. In the preparation of messages for transmission, and in the actual transmission of messages this system is almost identical with the Wheatstone automatic telegraph, and if the Wheatstone receiver were employed the messages would be recorded as dots, dashes and spaces.

The transmission of the six pulses of alternating polarity for each letter of the Buckingham alphabet operates a polarized relay in the main line at the receiving station, which relay by its armature controls two local circuits, in which are a governing relay, a unison magnet and an escapement magnet, the latter imparting, by means of an escapement, a step-by-step motion to a "sunflower," or distributor, of peculiar construction, to such purpose that, with the co-operation of the governing relay, and depending on the duration of the received pulses and the order of their arrival, one or more selecting relays are operated, and these, in turn, cause the operation of the type-moving levers which bring a desired letter on the type-wheel to the printing position. Hence the Buckingham printer is a positive or "step-by-step" system in which an escape-wheel, and with it the sunflower, is caused by a cycle of six pulses of current, one or more of which are prolonged, to undergo a cycle of six steps for each letter or character selected and printed. Consult author's ‹American Telegraphy and Encyclopedia of the Telegraph› for details of this system).

The Barclay Page Printer.— This system is a modification of the Buckingham page printer just briefly described. The operation of the Barclay printer up to the selecting relays is virtually similar to that of the Buckingham. At this point, in the Barclay arrangement the selecting relays, instead of operating the type-wheel shaft, are caused to select a given one of 30 or 32 electromagnets, each of which controls or operates a certain type of a typewriter which prints the letter; the message being printed by the typewriter in the ordinary way, by the aid of electrical devices. Messages may be transmitted by this system by means of a keyboard manipulated by an operator, or by means of perforated paper.

Murray Page Printer.— This printer is being used on the lines of the British Post-office. The messages to be transmitted are prepared somewhat as in the case of the method utilized in the Wheatstone automatic system. The perforated paper sends certain combinations of electrical pulsations for any given letter over a main line and these pulsations in turn operate apparatus at the receiving station which perforates a paper strip in a manner corresponding to the letters transmitted. This paper is then caused to pass before a set of metal strips which in their operation, and depending on the combination of perforations in the paper, select a certain letter of a typewriter, the message being thereby printed in page form. This system depends on synchronous movements of the transmitting and receiving apparatus, which is maintained by the action of the received pulsations upon apparatus in a local circuit at the receiving station. The speed of this system is about 103 words per minute. Consult Trans. Am. Inst. El. Engrs., 1901.

Baudot Multiple Printer.— This system is in successful operation on many of the telegraph lines of the French government. For its multiplex feature it employs devices practically similar to those described herein relative to Synchronous Multiplex Telegraphy. A keyboard is used, and letters are transmitted by depressing a given key which sends out the necessary combination of pulsations to reproduce a given letter at the receiving end, where by suitable selecting relays the given letter is selected and printed. The rate of signaling by this system is about 120 words per minute on one circuit. Consult Thomas' 'Traité de Telegraphique Electrique'; also *Electrical Review*, New York, 12 April 1899.

The Multiplex Printing Telegraph System. — In this country and in Great Britain a successful printing telegraph system based largely on the Baudot and Murray systems has been recently developed and by means of which eight and 12 messages are sent on one wire simultaneously at a rate of 40 and 30 words respectively, per minute.

A brief description of this system may be essayed here. In one respect it resembles the synchronous multiplex system previously described herein.

Thus it employs a number of insulated segments arranged circularly at each end of the circuit and over which a revolving brush or trailer is caused to pass. Instead of attaching a Morse key and relay to alternate segments of the circular disc, however, each of five consecutive segments of such a disc are connected at the transmitting end with a key, each key controlling a source of electromotive force, while at the receiving end of the circuit each of five corresponding consecutive segments of a segmental disc or ring is connected with a relay. There are four series of such consecutively connected keys and relays on the segmental discs. One or more of each series of keys may be depressed to form a certain combination of electric impulses representing a given letter, which impulses are transmitted by the trailer over the circuit and in turn these impulses operate a corresponding series of relays at the receiving station. These relays by their armature operate mechanism whereby a desired given letter is selected and printed in page form. As there are four series of keys and relays attached to the segmental discs it will be clear that four letters of four different given words or messages may be transmitted at every revolution of the trailer around the disc. The rate of transmission of words will then depend on the speed of rotation of the trailers, and this in turn is largely controlled by the mechanical and electrical limitations of the apparatus and line. In the Baudot system a keyboard is used to transmit a prearranged combination of electric impulses to form a letter. In the multiplex printing telegraph system under consideration the messages are transmitted by perforated paper strips, operating a transmitter, somewhat as described herein in the case of the Wheatstone automatic system. In the multiplex printer the paper is perforated by a keyboard perforator manipulated by an operator at a speed slightly greater than that of the automatic transmitter of the printer, and the paper there prepared is fed directly from the perforating machine into the said transmitter. By the foregoing arrangement four "channels" are provided on one wire and as the wire is duplexed in the manner described herein in connection with the Morse duplex system the equivalent of eight channels is obtained on one wire. As each channel may be operated at the rate of 40 words per minute a total of 320 words per minute is thus obtainable in practice on long circuits, the messages being printed in Roman letters on regular telegraph blanks in page form. Means are provided for the maintenance of exact synchronism between the transmitting and receiving trailers over their respective segmental discs — analogously as in the synchronous multiplex Morse system, but greater refinement of apparatus and operation is necessary in the multiplex printer. Obviously this must be so from the fact that in the multiplex printer means are provided for operating the typewriter carriage, printing the letters, etc.

The code or alphabet employed in this multiplex printing telegraph system is virtually similar to the Baudot alphabet. It is known as a five equal unit alphabet, that is, five impulses of positive or negative current are combined to form a given letter. Thus the letter *A* is assigned two positive and three negative impulses, *B* one positive, two negative and two positive units. Each current impulse in the Baudot code is of equal length and by different combinations of the five impulses it is possible to form 31 letters or characters. In the Morse code the dots and dashes representing letters and figures are of varying lengths, and hence a letter of the Morse code may consist of from 1 to 12 units. The average number of units in a letter of the continental Morse code is practically nine units per letter. It has been calculated that this disparity in the two codes results in an advantage for the Baudot alphabet in practice of about 65 per cent over the Continental Morse alphabet in the rate of transmission over circuits of equal length.

This multiplex printer rendered most efficient service in France under the direction of the United States Signal Corps.

Miscellaneous Telegraph Systems.— In addition to the telegraph systems referred to herein, many others have been in actual operation during the past century, either experimentally or commercially, among which may be mentioned the electrostatic systems of Lomond, Reusse, Reizen, Don Silva, Betancourt, Cavallo; Ronald's synchronous system; the electrolytic systems of Soemmering and Coxe; the chemical facsimile systems of Caselli, Bakewell, Denison and Bonelli's chemical printer; the chemical dot and dash systems of Bain, Morse, Anderson, Delany, Dyar; the electromagnetic systems of Alexander, Gauss and Weber, Steinheil, Schweiger; the needle systems of Wheatstone and Cooke, Davy; the dial systems of Siemens, Breguet, Kramer; the printers of House, Hughes, Phelps; the Meyer multiplex; the Mercadier multiplex and the Alteneck mechanical automatic system.

Telegraph Systems in Practical Operation.— Wherever the electric telegraph is employed the Morse system is the one most generally utilized. In some countries such as the United States and Canada, Sweden, Portugal, Switzerland, Egypt, Bulgaria, New Zealand, India, Australia and South America, the Morse system is used almost exclusively. In Great Britain, Italy, Russia, France, China, Japan, the Morse and the Wheatstone automatic, which is simply a fast Morse system, are largely employed. In Austria, Belgium, Great Britain, Hungary, Sweden, Russia, France, the Hughes printer is in extensive use. In France the Baudot printer is utilized; also in Italy, Holland and Switzerland to a limited extent. In Great Britain, about 750 Morse ink recorders; 925 Bright's

Bell; 5,000 A B C telegraph, 30 Delany multiplex and 4,700 single needle apparatus are in operation. All told there are approximately 70,000 Morse sets in operation in the United States and Canada, and 45,000 in all other parts of the world. There are in Europe about 1,700 Hughes apparatus, and in Europe and elsewhere about 530 Wheatstone automatic sets in operation. Needle systems; A B C and Bell apparatus are quite largely used in Europe on the railroad and commercial telegraph lines. A page printing telegraph system, termed Morkrum Printer, is also in extensive use in the United States.

It may be remarked that there is a desire on the part of the telegraphing public in all countries to receive telegrams in type and in page form, and as far as practicable the various telegraph administrations are endeavoring to comply therewith. In the United States, as already intimated, the Morse operators in numerous instances transcribe messages by the typewriter as received. In Great Britain the Murray page printer has been adopted by the government, and in Europe generally, where messages are received on paper strips as by the Hughes and Baudot systems, the strips are pasted on blanks in page form, for delivery.

Speed of Different Systems.— The average speed of transmission by the Morse manual telegraph may be placed at about 20 to 25 words per minute, although skilful operators attain a speed of 45 and 50 words per minute. The speed by the Wheatstone system on short lines is about 500 to 600 words per minute. By the Hughes an average of about 30 words per minute in one direction is obtained. This system may be duplexed, giving 50 words per minute on one wire. By the Baudot system, operating as a quadruplex, 120 words per minute; as a sextuplex, 180 words per minute. By the Buckingham and the Barclay systems a speed of 80 words per minute, in each direction, may be obtained on circuits from New York to Chicago, with repeaters midway. By the Murray printer, about 80 to 100 words per minute in each direction may be obtained.

Mileage of Telegraph Lines, Wires and Submarine Cables.— In the United States the total amount of pole lines is about 238,000 miles, on which about 1,270,000 miles of copper and iron wire are erected. In Canada there are about 35,000 miles of lines and 84,500 miles of wire. In both cases the various railroad companies also operate a considerable amount of telegraph line (about 250,000 miles of wire) for the movement of trains, etc. In all other parts of the world there are approximately 435,000 miles of telegraph pole line and 1,450,000 miles of wire, exclusive of about 48,000 miles of pole lines and 216,000 miles of wire controlled by railroads. The average size of the copper wire used on telegraph pole lines is No. 12 or 14 B. & S. gauge; that of iron wire, No. 6 or 8. The nature and size of the poles varies in different countries. Cedar is largely used in the United States and Canada; fir in Europe. Poles 30 to 40 feet long and set five feet in the earth are used. Thirty to 40 poles to the mile has been common practice, but the tendency in this country is toward the use of 45, 50 and more poles per mile to obtain greater security against sleet and wind storms. Iron telegraph poles are used in some countries.

The amount of submarine cables in all parts of the world is about 200,000 miles. Of this amount about 27,500 miles are owned and controlled by governments; the remainder is owned and operated by private companies. In all there are about 1,000 submarine cables of varying length in different parts of the globe.

While, as stated, the telegraph systems of the United States and Canada are mainly operated by private companies, the governments of both of these countries have constructed and laid for their own purposes many miles of overhead lines and submarine cables. Thus the United States government has constructed its own telegraph lines and cables in Alaska and the Philippines. The Alaskan lines extend from Seattle, Wash., to Nomé, Alaska, a distance of 3,625 miles, including 1,439 miles of land lines, 2,079 miles of submarine cable and a wireless circuits of 107 miles in length. The government handles private commercial messages on these lines at a regular fixed charge. The Canadian government owns and operates about 3,900 miles of land lines and cables. The bulletins giving the movements of fish in the waters of the Gulf of Saint Lawrence and other shore lines, together with messages relating to weather, quarantine and signal service, are transmitted free of charge.

Administration of the Telegraph.— The administration of the telegraph is to-day in the hands of the government in all parts of the world. The actual management of the telegraph systems of the various countries of the world is, of course, in the hands of the proper authorities of those countries, but, in general, the disposition of all matters that relate to the regulation of international telegraph traffic, such, for instance, as the maximum number of letters that shall constitute a word, the alphabet to be used, etc., is reposed in the hands of the International Bureau of Telegraph Administrations, Berne, Switzerland. In fact, however, even the United States and Canada incidentally come under the control of this bureau in so far as relates to the intercommunication of telegrams with countries under the jurisdiction of the bureau. Thus if the bureau decides that the maximum number of letters in a word for telegraph purposes shall be 10, the countries mentioned must perforce comply with that regulation as regards telegrams that may be destined for or that may emanate from territory wholly within the jurisdiction of the international bureau.

William Maver, Jr.,
Author of ‹American Telegraphy and Encyclopedia of the Telegraph.›

TELEGRAPHY, Submarine Sound, a system of communication between steamships at sea by sound telegraph through water. In 1901 A. J. Mundy tested an experimental boat in Boston Harbor, based on experiments in the conductivity of sound through liquids by Prof. Elisha Gray. Experiments by J. B. Millet proved remarkably successful. Signals were exchanged between lightship bell and a ship seven miles distant at sea. Sound travels faster through water or liquids than air, and this is taken advantage of in a practical way. In the ship at sea are two sound receivers, one upon each side in the hold, located approximately 20 feet below the surface of the water. The lightship has the sounding bell hung through a well in the centre of the ship, about 25 feet below the bottom. It also has a receiving apparatus. Near the lighthouse on shore is a buoy from which depends a bell, with a pipe leading to the shore to a compressed-air reservoir in the lighthouse. The bell is suspended by a main chain, while a second operating chain is attached at its lower end to the bell crank of the hammer, and the upper end to a pneumatic piston, which is operated by compressed air either from the anchored lightship or the lighthouse, as the case may be, or it may be operated by a direct upward pull by manual power if desired. It has been ascertained that the receiver for collecting the sound vibrations need not be located on the outside of the vessel, but operates as well when clamped on the inside against the inner surface of the outer hull, especially in iron ships. The sound vibration from the bell passing through the water is communicated to the side of the ship's hull, and that in turn to the liquid or water in the receiver; which is a cup-shaped metal cylinder having the open end clamped against the side of the hull. Inserted in the top of the receiver is an electric transmitter, something on the order of a telephone transmitter, from which wires are run to the pilot-house of the ship. As the sound travels through the water in every direction from its source, it is found that the impulse will be stronger and louder on the side of the ship nearest to the source. By this means the direction of the sounding bell is ascertained, for by listening to the telephone receiver attached to the starboard side water receiver, and then switching over to the port side and listening to that telephone receiver, the ear detects at once which is the louder sound of the two. This was determined experimentally by turning the ship around in a large circle. In foggy weather, signals of this kind are readily heard, regardless of which way the wind is blowing. The usefulness of the system in safeguarding ships against collisions at sea at night or in a fog is evident. Simon Lake, inventor of the Lake submarine boat, has experimented with under-water telephony with considerable success and applied it to his undersea craft.

TELEGRAPHY, Wireless. During the past 20 years attempts have been made, with more or less success, to avail of electromagnetic induction for signaling to a distance without wires, by means of what have been termed induction telegraph systems. Such systems employ in their operation the well-known principle that when an electric current is rising or falling in one wire it will develop by induction a current in a neighboring parallel wire. Phelps and Edison have employed this principle in signaling to and from moving trains. These systems were in operation for a time on several railroads in this country, but were eventually abandoned for lack of patronage. Preece also, in Great Britain, devised and had in operation a wireless induction telegraph system. In the Preece system a wire several miles in length is strung on poles along the coast of the mainland, a parallel wire being erected on poles along the shore of an island. These wires are placed in the earth, or «grounded,» at their respective terminals. By employing a battery, an induction coil and a Morse telegraph key in one of the wires, and a telephone receiver in the other, it is feasible to transmit signals by induction (possibly assisted by conduction through the water), without connecting wires, across an intervening space of two to four miles. In the operation of these induction telegraph systems from 50 to 300 electromagnetic pulsations or waves per second are utilized.

Notable as the results obtained by induction telegraph systems were considered at one time, they have been completely overshadowed by those systems in which electric waves or oscillations of a much higher order, namely, from many thousands to several millions per second, are utilized, and to which systems the term «wireless telegraphy» is now generally applied. The term «radio telegraphy» is, however, also much used.

The growth of present-day electric wireless telegraphy has been comparatively slow and the discovery and development of the art can scarcely be placed to the credit of any one mind. In 1864 Clerk-Maxwell demonstrated mathematically the electromagnetic theory of light, which in effect is that electromagnetic manifestations are due to undulations of the all-pervading ether, of a nature more or less similar to the undulations of the ether which produce the manifestations of light, and that, in so far as they differ, it is mainly a difference as to the number of oscillations per second, the undulations that produce the sensation of light occurring, for instance, at the rate of from four hundred million of millions per second, to seven hundred million of millions per second; while, as just intimated, the electric undulations may not exceed a few millions per second.

After the announcement of the electromagnetic theory of light, which involved the existence of electric waves in free space, many scientists endeavored to demonstrate experimentally the truth of the theory. This honor fell to Prof. H. Hertz in 1887. It had been shown by Professor Henry in 1842 and by Sir William Thomson (Lord Kelvin) in 1853 that when a Leyden jar or other highly insulated condenser is discharged, the previous charge is not dissipated in one rush, but gradually, in a series of oscillations.

It is well known that in an electric circuit containing coils of wire the current is perceptibly retarded in rising and falling, which fact is due to a property termed inductance, which all conductors possess. On the contrary, when a wire possesses electro-static capacity the current is assisted in rising and accelerated in falling. The property of inductance is usually likened to inertia, while capacity is likened to elasticity, in mechanics. The shortest electric wave thus far produced is about .15 inch in length. This is still much longer than the longest light-wave and 60 or 70 times longer than the longest dark heat wave yet measured. In the electric circuits employed in wireless telegraphy the resistance is small. In fact, if the resistance be too great the discharge will not be oscillatory. The time of an oscillation period is expressed by the formula

$T = 2\pi\sqrt{KL}$; where T is the time in seconds, π is ratio of circumference to diameter (3.1416), K is capacity in farads, and L the inductance in henrys; resistance R being neglected.

In proceeding with his experiments, Hertz reasoned that, analogously as light-waves affect the eye when they fall upon it, so should electric waves in the ether affect a suitable «eye» or detector when they fall upon it. The apparatus employed by Hertz to show the existence of electric waves in the ether of free space consisted of an electric oscillator for setting up electric waves in the ether, and an electric resonator to detect the waves. The circuit in which electric oscillations are set up emit electric waves in the ether. The Hertz oscillator and detector are shown in Fig. 1. The generator of the oscillations consists of an induction coil *I*, the terminals of its secondary wire being connected to small metal balls *b, b*, to which short metal cylinders, or wings, *w w* are attached. The balls are separated by a small air space, or spark-gap *s*, across which sparks jump when the coil is in operation. The vibrations of the interrupter *a* set up pulsations of current, due to battery *B*, in the primary circuit of the induction coil, which pulsations, by magnetic induction, cause alternations of greatly enhanced electromotive force in the secondary circuit. When the electric pressure rises to a point sufficient to break down the resistance of the air space between the balls *b, b*, oscillations surge back and forth in the oscillating circuit *w, b, s, b, w*, the rate of which oscillations will vary with the electrical dimensions of the circuit, namely, inductance, capacity and resistance. The rate at which the interrupter of an induction coil vibrates may vary from 50 or less to hundreds of vibrations per second. The oscillations of the electric oscillator may be many millions per second. It is evident, therefore, that the induction coil, or other alternating current generator, merely serves to strike the blow, so to speak, that sets up the rapid electric oscillations in the oscillating circuit, analogously as when we wish to keep a tuning-fork in vibration we must strike it at intervals. As a detector, Hertz employed a copper wire of circular shape, but broken at one point. On the ends of this wire he placed small metal knobs, *d*, the distance between which could be regulated by a micrometer screw. This wire was supported on an insulating stand in a darkened room and small sparks could be seen passing between the knobs *d* when oscillations were established in the oscillating circuit *w, b, s, b, w*. The results of this experiment were held to demonstrate the existence of electric waves in the ether, as predicted by Maxwell.

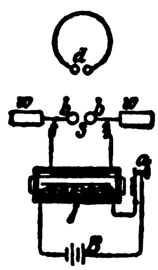


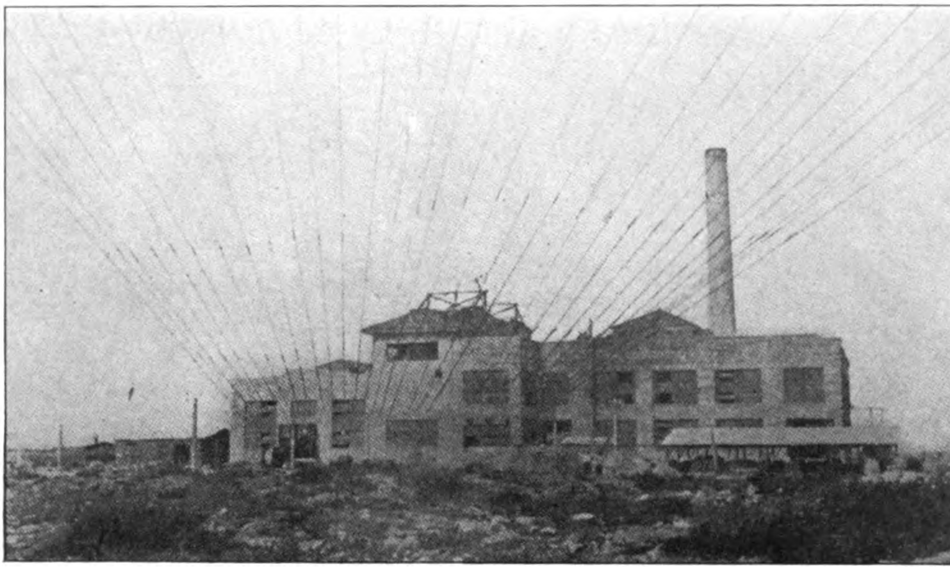
FIG. 1.—Oscillator and Detector.

The distance at which electric waves are detected by the Hertz devices is very limited, perhaps not more than 10 or 12 feet at most. These devices, however, demonstrated the possibility of signaling to a distance by electric waves. Not long after the announcement of Hertz's experiments, Dr. Branly discovered that metal filings, when thrown together loosely and made part of an electric circuit, have normally a high resistance, but under the influence of electric oscillations they lose this resistance and become good conductors of an electric current. It is assumed in explanation of this effect that the electromotive forces that accompany the electric oscillations in the circuit cause the filings, by electrostatic attraction, to cohere, thereby making a better electrical contact with one another, thus reducing the resistance of the circuit; hence the application of the term «coherer» to this type of electric wave detector. It was also found that when the filings had cohered they retained their electrical conductivity until they were jarred, or otherwise mechanically disturbed.

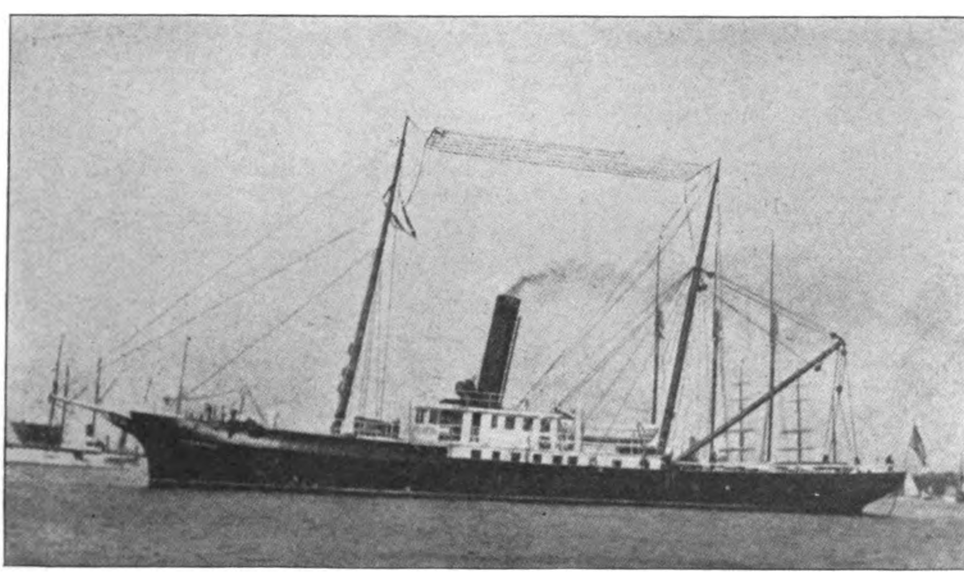
In 1894 Dr. O. Lodge (now Sir O. Lodge), in a lecture before the Royal Society, London, showed that the filings coherer could be used to transmit signals telegraphically by placing them in a glass tube and making them part of an electric circuit in which were a battery and a telegraph receiver. In this experiment when the induction coil was operated at a distance of some yards from the coherer the latter was actuated. In order that the filings should not remain cohered after the oscillations had ceased, the hammer of a bell operated by clock-work was caused to strike or tap the glass tube as long as the electric oscillations continued. An electric bell has generally been employed in the later use of the filings coherer. In 1895–96 Popoff and others utilized the filings coherer as a means of detecting atmospheric electricity, employing for this purpose a vertical wire extending many feet into the air, the coherer being placed between the lower end of the vertical wire and the earth.

Theories of Electric Wave Propagation.— Obviously substances opaque to light obstruct the passage of the luminiferous ether waves. Analogously it was thought in the early days of electric wireless telegraphy, that the curvature of the earth or sea between points several hundred miles apart would prove a barrier to electric waves traveling, like light-waves, in straight lines, inasmuch as it would not be practicable to obtain masts, or other means of support for vertical wires, of sufficient height to overlook the barrier. Later experiments showed that with wires only 200 feet high signals could be transmitted to points between which there was a wall of earth or water 15 or 20 miles in height, due to the curvature of the earth. A number of theories have been advanced in explanation of this fact. For example, that the waves are propagated around the earth by diffraction or reflection, but these theories are not generally held to be tenable. A theory that meets with most acceptance at present is that the electric waves are propagated as sliding waves over the surface of the earth or sea.

Brief allusion may be made to the supposed action that takes place in and around the Hertz oscillator in the production of free electric waves in the ether. The Hertz oscillator corresponds to a condenser with widely separated plates. In the act of electrically charging the arms or rods of the oscillator, lines of force or strain spring out all around the rods in the dielectric, that is, the air surrounding the rods. To fix ideas these lines of force may be likened



Typical power plant of a Marconi long-distance station, showing aerial wires leading into the building



The Yankee Salvage Association's tug Forward, which sends ashore the press reports to the vicinity of New York Harbor

to highly elastic hoops, partially flattened out, and with their ends resting on the rods. One end of the lines of force is assumed to be positive, the other negative. These hoops or lines resist straightening out and their resistance to the strain increases the further they are straightened out, until their back pressure equals the charging force. According to Maxwell's theory of displacement currents in dielectrics, during the process of applying this strain a displacement current flows in the circuit, and when the counter pressure of the lines equals that of the charging force the displacement current ceases to flow. At this time the rods of the oscillating circuit have acquired the potential of the charging electromotive force. When the external electromotive force reaches a point where it breaks down the resistance of the air gap, the energy stored in the dielectric is returned to the circuit and a current flows across the gap and the strain in the dielectric is thereby relieved, concurrently (Poynting) with which the ends of the lines of strain contract, one end sliding down the rod, the other gliding up the rod toward the air gap. The extreme outside portion of the lines also tend to contract, but as such portions of the lines move more slowly than the ends, the latter meet, and as they cannot pass one another, the lines are snapped or whipped off, perhaps like rings of smoke from the smoke-stack of a locomotive, forming closed electric lines of force which are radiated into space. Coincidentally also with, and as a result of, the collapse of the electric lines of force, magnetic lines of force are set up concentric with the Hertz rods and at right angles to the electric lines of force. When the magnetic lines of force reach their maximum the electric lines of strain will have vanished. Immediately, however, the magnetic lines of force now begin to collapse and are detached, their collapse setting up new electric lines of strain. These processes are repeated until the oscillations cease, to be renewed when the rods are again charged and the spark gap again breaks down. The detached lines of force thus jointly constitute electric radiation, or free electric waves which are propagated as ever-expanding electromagnetic waves in free space. Any portion of these waves on reaching a receiving vertical wire excite therein the electric oscillations which affect the coherer or other detector.

Theory shows that the grounded vertical wire may be considered to be equal to one-half of a Hertz oscillator (Fig. 1). The other half being the ground itself. On this assumption the earth is a perfect conductor — therefore a reflector of high frequency electric waves — and the vertical wire may be supposed to have a reflected counterpart below it, virtually like the image seen under a pencil standing vertically on the surface of a mirror lying horizontally on a table. This is in accordance with what is termed the image theory, advanced by Delaricci and Blondel. The electric oscillations in such a system may then correspond to those in the Hertz oscillator, a complete oscillation consisting in a wave from the spark-gap to the top of the antenna back to the spark-gap, thence to the foot of the reflected or imaginary wire and back to the spark-gap, which constitutes a wave length four times that of the vertical wire proper.

Marconi's Early Experiments and Work. — The Lodge experiments in 1894 were followed by those of G. Marconi of Italy in 1895. In these experiments Marconi employed an induction coil, a Morse telegraph key, batteries and vertical wire, for the transmission of signals, and for the reception of signals, a filings coherer, a telegraph relay, batteries and vertical wire. The general arrangement of Marconi's simplest apparatus is outlined in Figs 2 and 3. In Fig 2, *I* is the induction coil, *a* is its interrupter, *p* is the primary wire, *s* is the secondary wire of induction coil, *B* is a storage battery of about five cells. *K* is the Morse key; *b b'* are the spark balls. The vertical wire *A* at its lower end is connected to ball *b*; the other ball *b'* is connected with a wire leading to the earth. Balls *b b'* of the oscillator are thus in series with the vertical wire. The terminals *w w'* of the secondary wire are also connected respectively to *b* and *b'*. The receiving apparatus is

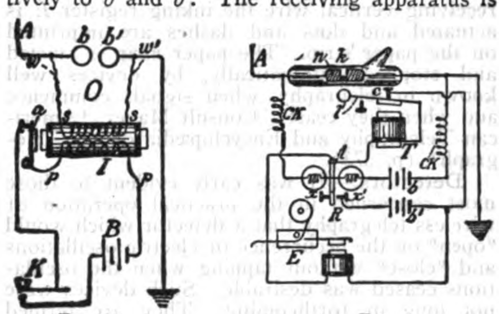


FIG. 2. FIG. 3.

Marconi Earlier Experiments.

outlined in Fig. 3. The Marconi filings coherer is shown at *k*. It consists of a glass tube, suitably upheld, about 1.57 inches long and .1 inch inside diameter. The filings, a mixture of 90 per cent nickel and 10 per cent silver filings, are inserted in a small space between two plugs *n*, which fit snugly into the tube which is exhausted of air. Small wires extend from these plugs to the outside of the tube. One of these wires is connected with the vertical wire *A*, the other with a wire leading to the earth. Hence the coherer is in series with the vertical wire. The relay *R* is in a shunt circuit with a single cell of battery *b* and the coherer, as shown. The armature lever *l* of this relay controls the local circuits of the electric bell *T* and an ink recording register *E*, which are operated by local battery *b'* of four or six cells.

The actual transmission of messages is effected by means of key *K*, Fig. 2. Each time the key is closed the vibrator *a* starts into operation with the result that electric oscillations are set up in the vertical wire and a train of electric waves is radiated therefrom in the ether. Thus by opening and closing the key for a shorter or longer time the train of waves is broken up into signals corresponding to dots and dashes which are received as such at the receiving station. The operation at the receiving station is practically as follows: Normally the armature lever *l* of the tapper *T* is given a tension which holds it against the contact *c*. Normally, also, the armature lever *l* of relay *R* is on its back stop *x*. Hence at this time the local circuit of battery *b'* is open. When then the electric waves set up by the oscillator arrive and electric oscillations are thereby excited in the vertical wire at the receiving station, the resistance of the coherer drops sufficiently to allow the battery *b* to energize the relay *R* and its lever *l* moves over to contact *x'*, closing thereby the circuit of battery *b'*, whereupon the electromagnet of tapper *T* attracts its armature *l'*, which act opens its own circuit at contact point *c*. At once the armature of *T* flies back on its contact point, at the same time striking the tube, decohering the filings and demagnetizing relay *R*, whose armature lever returns to its back stop *x*. Immediately, however, the filings again cohere (assuming that the oscillations continue), with the result that *R* is again magnetized, the actions just described being repeated many times in a second. Hence, while the oscillations are being received the tapper keeps up a buzz or hum, which stops when the oscillations cease. Likewise, while the oscillations continue in the receiving vertical wire the inking register *E* is actuated and dots and dashes are imprinted on the paper strip. The paper strip is started and stopped automatically, by devices well known in telegraphy, when signals commence and when they cease. Consult Maver, 'American Telegraphy and Encyclopædia of the Telegraph' (p. 373).

Detectors.— It was early evident to those most concerned in the practical operation of wireless telegraphy that a detector which would «open» on the occurrence of electric oscillations and «close» without tapping when the oscillations ceased was desirable. Such devices were not long in forthcoming. They are termed detectors.

One of the first detectors used in wireless telegraphy is due to Castelli. Detectors have also been devised by Marconi, DeForest, Fessenden and others. The Castelli detector is outlined in Fig. 4. It consists of a glass tube

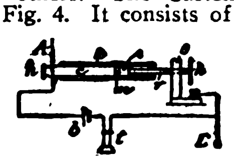


FIG. 4. — Castelli Detector.

K, 1.7 inches in length, a carbon rod *c*, a plug of iron *i* within the tube, and a small drop of mercury *m*, placed between *c* and *i*. The rod *c* and plug *i* are adjustable within the tube by the screws *h*, *h*. *A* is the vertical wire which is made a part of the coherer circuit. A telephone receiver *t* and a small battery *b* are placed in a shunt circuit around the detector. Normally, the imperfect contact between the mercury and the carbon causes a high resistance in the detector, but when electric oscillations occur in the circuit the mercury and the carbon cohere and the resistance falls. The consequent variations of current in the shunt circuit produce sounds in the telephone receiver of long and short duration corresponding to the dashes and dots transmitted. This detector was used extensively in the Italian navy and was used by Marconi in some of his trans-Atlantic experiments.

Among other detectors are the carborundum, due to General Dunwoody of Washington, D. C.; the DeForest Audion, and the Silicon detector of Mr. G. W. Pickard of Amesbury, Mass. The Dunwoody detector consists of a small crystal of carborundum clamped at its edges between two metal electrodes or terminals. It is placed in circuit with a small battery and a telephone receiver. Its operation appears to depend on the development of heat, due to the local battery, at the minute points of contact, which heat reduces the resistance of the carborundum. Incoming oscillations affect this resistance and thus produce sounds in the telephone. The sensitiveness of this detector is somewhat greater than the filings coherer. It possesses the advantage for shipboard use that jarring does not disturb its operation.

The Silicon Detector.— Detectors of this type are now termed crystal detectors. This detector employs in its operation the principal of the thermo-electric couple. (See THERMO-ELECTRICITY). The electrodes or thermo-electric couple employed by Mr. Pickard in this receiver are pure silicon and a metallic element of low resistance under a certain mechanical pressure. This couple is placed in the receiving oscillation circuit in which is also placed a telephone receiver, but no battery. According to the inventor the received oscillations are converted into heat at the thermo-electric couple, the amount of heat developed being in accordance with the C^2R law, the energy of which is converted into direct electric currents which are heard in the telephone receiver as sounds. Tests by Pickard of a number of the best known electric wave detectors show the amount of energy required to give a just audible dot (or sound) in the telephone receiver to be as follows: Electrolytic detector, .000364 to .000400 Erg.; Magnetic detector, .000400 to .000410 Erg.; Silicon detector, .000430 to .000450 Erg.; Carborundum detector, .009000 to .014000 Erg.

Vacuum Tube Detectors.— The most useful detector of wireless telegraph and telephone signals to-day is the vacuum tube detector. It has been known for a number of years that the air or gas surrounding an incandescent wire or filament is ionized due to electrons escaping from the incandescent body. The Edison «effect» discovered in the last century was due to this fact, but the correct explanation was not forthcoming at that time. Thus in Houston's 'Electrical Directory,' published in 1892, the Edison effect is defined as follows: «An electric discharge which occurs between one of the terminals of the incandescent filament of an electric lamp placed near the filament but disconnected therefrom, as soon as a certain difference of potential is reached between the lamp terminals. The effect of the discharge is to produce a current in a circuit connected to one pole of the lamp terminals and the metallic plate, as may be shown by means of a galvonometer.» The vacuum tube detector is based primarily on the Edison effect. Apparatus and circuits to show this effect are outlined in Fig. 5. An electric current from a battery *A* heats the filament or wire *F* to a desired temperature when it is found that the platinum plate *W* adjacent to, but not touching *F*, becomes positively electrified to a few volts, as shown by a galvanometer *G*, this indicating that the intermediate gas is ionized or rendered electrically conducting. In the later use of vacuum tubes for X-ray work, wireless telegraphy and telephony, very high vacuums are used which give a pure electron discharge, with greatly improved results, especially perhaps in X-ray work.

The number of electrons flowing from the filament to the plate in a high vacuum tube

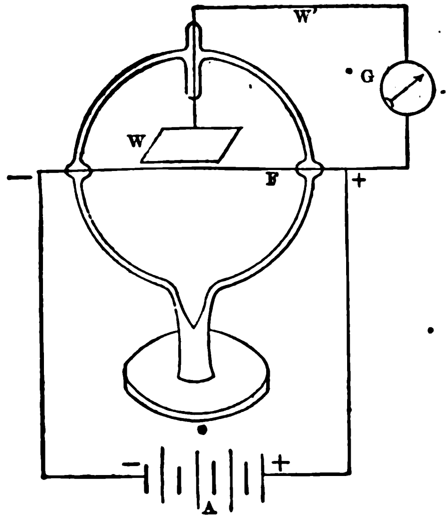


Fig. 5. — Theory of "Edison Effect."

depends on the temperature of the filament and the potential or space charge of the plate. The amount of current in the filament to plate circuit depends on the number of electrons released or emitted from the filament and has been calculated to correspond to 10^{19} electrons per ampere. After a certain increase in the temperature of the filament, which is limited by the strength of its material, and at a certain positive potential of the plate, saturation is reached. The flow of electrons, which are assumed to be negatively electrically charged particles, is apparently from the filament to the plate, which is charged with positive potential, while the current flow is from the plate to the filament.

As already noted the bulbs used in this service require an exceedingly high vacuum for their proper operation. It is also important that the filament and other metallic elements of the tube be free of gas.

Fleming Valve Detector.— Fleming improved upon and utilized the foregoing Edison device by making it a wireless detector known as the Fleming valve or current rectifier, Fig. 6. In the figure *A* is the aerial; *p*, *s* are the

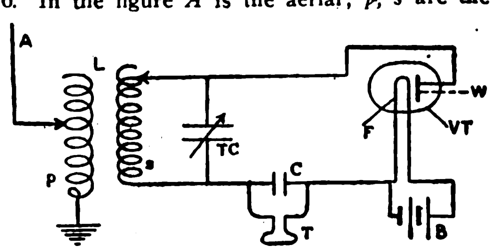


Fig. 6.— Fleming Valve Detector.

primary and secondary coils of the receiving transformer *L*. *TC* is a variable condenser. *VT* is the vacuum tube detector. Plate *W* is part of an oscillation circuit *S*, *C*, *F*, *W*. Filament *F* is brought to incandescence by the battery *B*; this releasing electrons at the filament. Incoming oscillations from the aerial due to arriving Morse signals set up alternations of positive and negative potential on plate *W*. When the plate is charged positively the negative electrons are drawn over from the filament, increasing the potential on *W* which in turn charges the condenser *C* at that instant. When the plate *W* is charged by incoming negative oscillations electrons do not pass from *F*. Hence positive or uni-directional currents only are allowed to pass. Between the positive charges of plate *W*, the condenser *C* discharges through the telephone receiver *T*, thereby reproducing the transmitted dot and dash signals.

The De Forest Audion.— To the Fleming valve de Forest added a metal grid *G* (Fig. 7) between the filament *F* and the plate *P*, making it a three electrode tube *VT*. He also added a potential battery *PB* to plate *P*, which combination produces remarkable results. De Forest termed this device the audion, from the words audible and ion. *A* is an aerial; *p*, *s*, are the primary and secondary coils of the tuning coil or receiving transformer *L*. *TC* is a variable, or adjustable, tuning condenser. *C* is the grid condenser. The grid *G* intercepts the electrons flowing from *F* to *P*, and it is found that a given variation of voltage in the grid produces a greater variation in the plate currents than is effected by a similar variation of potential on the plate *P* with the grid removed. The incoming oscillations from the aerial in the grid-filament circuit are repeated or relayed into the grid-plate circuit more or less amplified. This fact constitutes the audion an amplifier of current and consequently of sounds, and because of this relaying property the audion is also termed an electron relay.

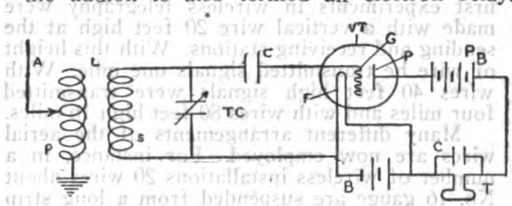


Fig. 7.— De Forest Audion.

Figs. 6 and 7 may be regarded as showing theoretically the ordinary wireless receiving circuits in which the respective detectors indicated are employed.

Another way of regarding the operation of the vacuum tube is to assume that the heated filament sets up a negative electromotive force due to the presence of negative electrons. The potential battery *PB* produces a positive potential at the plate. The conventional explanation then would be that the current flows from the positive potential at the plate to the negative potential at the filament; the battery in this case providing the supply of electrons or, in other words, the current. On this hypothesis a reduction of the negative potential at the filament, the potential at the plate remaining the same, will cause a reduction of current between *F* and *P*. Similarly a reduction in the positive potential at the plate will reduce the current. By obtaining control of the potential of the plate and grid a variation in the output of the tube is obtained. The grid element in the tube provides a means of varying the plate potential, and reversely a variation in the plate potential affects in an opposite sense the potential of the grid.

The three electrode vacuum tube has recently undergone great improvements at the hands of many experimenters, and it is now not only utilized as a detector and amplifier of wireless telegraph and telephone currents, but also as a generator of high frequency electrical oscillations and a modulator of radio waves in Wireless Telephony (q.v.). This tube is also employed as a repeater or relay in long distance wire telephony and indeed it is largely due to the amplifying and relaying properties of this instrument that trans-continental telephony is commercially possible.

There are at least three variations of this tube now in use, termed, respectively: The kenotron, the pliotron and the dynatron. «The kenotron rectifier utilizes the unidirectional property of the current between a hot and cold electrode in vacuum. The pliotron utilizes the space charge property of this current which allows the current to be controlled by the electrostatic effect of a grid. The dynatron utilizes the secondary emission of electrons by a plate upon which the primary electrons fall; it is, as its name indicates, a generator of electric power and feeds energy into any circuit to which it is connected.» For fuller information on this subject the reader is referred to the ‹Proceedings› of the Institute of Radio Engineers, September 1915, and to the bibliography appended thereto. For details relating to and for other examples of circuits in which the three electrode tube is utilized see TELEPHONY, WIRELESS.

The Vertical Wire or Aerial.— Marconi's first experiments in wireless telegraphy were made with a vertical wire 20 feet high at the sending and receiving stations. With this height of wire he transmitted signals one mile. With wires 40 feet high signals were transmitted four miles and with wires 80 feet high 16 miles.

Many different arrangements of the aerial wires are now employed. For instance, in a number of wireless installations 20 wires about No. 16 gauge are suspended from a long strip of wood, which is upheld by insulators supported by a rope between the tops of two masts about 150 or 200 feet high. The wires, two feet apart, drop vertically to a similar wooden strip, where the wires are joined together and led into the instrument room. In other cases the wires are suspended from towers by well-insulated arms and are kept apart by wooden spreaders until near the ground, where the wires are connected and thence are carried into the operating room. In still other cases a single mast is employed, from the top of which a number of wires are suspended. Each wire is attached, at a distance of about 50 feet from the top of the mast, to a guy-rope, which is itself attached to an anchor post in the earth, 40 feet or more from the base of the mast. The guy-rope thus first draws the wires away obliquely from the mast, then at its point of connection with the guy-rope each wire is drawn toward the foot of the mast, where all the wires converge and are thence led into the operating room; the wires forming a >, with the mast as a base and no spreaders are required.

In Fig. 8 are shown various ways in which two or more aerial wires may be employed as antennæ. The wires may be of varying length depending on requirements. In the figure, *a* may represent two wires open or closed at top, *c* indicates a four-wire arrangement; *f* is a cage arrangement of four, six or more wires in which the wires are held apart by hoops; *g* is a box method in which the wires are separated by a wooden frame. The plan shown at *c* is much used. The wires in this case are held apart by wooden spreaders

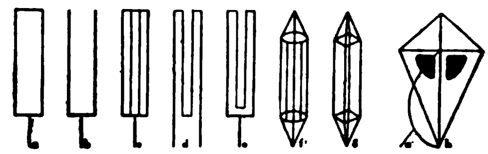


FIG. 8.— Some Forms of Aerials.

at the top and bottom and also at the middle if the wires are very long; *a* represents an Eddy Kite arrangement for supporting an aerial; two or more of these kites may be used in tandem.

Again two high masts or towers 100 and more feet apart are employed, having a number of horizontal wires strung between them at their tops. Vertical wires are attached to the horizontal wires and are dropped to a wooden strip and thence are led into the instrument room. On shipboard horizontal wires are usually strung between the tops of one fore-mast and one aft-mast, from which horizontal wires the vertical wires of the antennæ are conducted to the operating room.

For the very powerful wireless stations much more elaborate antennæ than those described are necessary. For instance, at the Belmar, N. J., station on the Atlantic Coast four iron masts are usually arranged in alignment at right angles to the coast. These masts are 300 feet high and are about one-quarter of a mile apart. Horizontal wires are supported by these masts and vertical wires are connected therewith, which are led into the station.

Kites and captive balloons for supporting the vertical wires have frequently been availed of for temporary use and for military operations. The material of the vertical wire does not appear to affect the results. Iron, copper and aluminum wires have been used. Wire netting has also been employed. The insulation of the vertical wires from the mast is, however, very important. Good earth connection for the vertical wire has been found very essential in practice, especially at the transmitting end. Copper plates 30 feet long and 4 feet wide, embedded two or three feet in damp earth, giving about 2,400 feet of plate surface, are sometimes used for this purpose. When feasible the ground plate is sunk in the sea. On shipboard the «earth» is secured by attaching a wire to bolts on the iron frame of the vessel.

The main object in employing a number of aerial wires or antennæ has been to obtain increased capacity wherein to store electrical energy to be radiated as electric waves, the vertical wires being virtually one plate of a condenser, the earth the other plate and the air the insulating medium. The effective capacity of closely adjacent parallel wires is not, however, proportional to the number of such wires, but is equal, roughly, to the square root of the number of wires. The capacity of a vertical wire .1 inch in diameter and 100 feet in length is .0002 micro-farad (Fleming).

For ordinary service the grounded antenna has been found to operate satisfactorily, but for tuned circuits the direct earth connection possesses some disadvantages. Thus variations in the resistance of the earth connections have introduced difficulties in the way of maintaining exact tuning or syntony. (Described subsequently).

In shipboard practice the aerials *A* are frequently extended in a sort of cage arrangement *C* from the heads of the fore- and aft-masts as outlined in Fig. 9. The cage con-

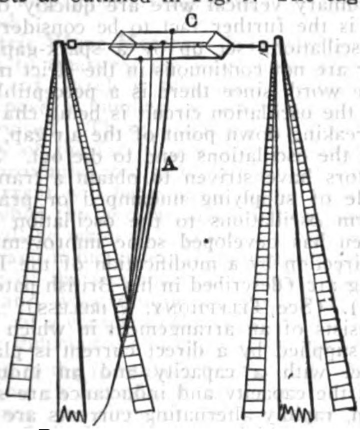


Fig. 9. — Shipboard Aerial Wires.

sists of wires held apart by insulated hoops or spreaders. This cage arrangement is also used in land or shore stations. In this case the cage is about 20 feet in length and consists of six or eight wires. The upper end of the cage is attached in the usual way to the top of the mast or tower; a single wire suspended more or less obliquely connects the cage with the wireless apparatus.

On shipboard when the available masts are low the number of wires must be increased to obtain capacity in the radiating system. A type of aerial much used on ships and at shore stations is that known as the *T* or *L* aerial. An *L* aerial is indicated in Fig. 10, in which between two masts six horizontal wires *W* are supported and from which 6 vertical wires *W'* held apart by wooden spreaders *S* are dropped

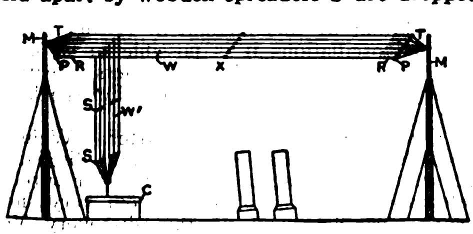


Fig. 10.— Shipboard L Aerial.

to a point near the deck where they converge and after being cabled are led into an operating room *C*. In a *T* aerial the vertical wires are attached to the horizontal wires at *X*. In the *L* arrangement the horizontal wires, which possibly give a directive tendency to the aerial waves, are connected at the far end. The horizontal wires are supported by corrugated insulators *R*, about two feet in length, and are attached to the masthead *M* by suitable tackle *T*, which upholds the spar *P* 15 feet in length and to which the insulators are fastened. The horizontal wires are two and five feet apart.

Condensers.— The condensers used in transmitting circuits for installations up to one or two kilowatts are generally of the Leyden jar-type. Such jars, 16 inches high by 5.25 inches in diameter, have a capacity of .004 micro-farad. For more powerful installations, large plate-glass condensers immersed in oil, contained in insulated tanks, have been used by Marconi, De Forest, Fessenden and others.

Generators of Electric Oscillations.— The need of greater radiating power in long distance wireless transmission than is obtainable from the ordinary induction coil, as well as the unreliability of the interrupters of such coils, when used with large currents, which soon wear out the contact points, has led to the adoption of special types of transformers. Instead of battery power also, alternating current generators are employed as the source of electromotive force for these transformers. The power of the generators may vary from 1 kilowatt to 300 or more kilowatts. The rate of alternations of the transformer depends on the frequency of the generator. The electromotive force in the primary circuit of the transformer may be from 50 to 200 volts, which is greatly increased at the secondary terminals of the transformer; in some cases to 20,000 or 50,000 volts. In the case of the New Brunswick, N. J., transatlantic station a 60-cycle 24,000-volt current in the secondary circuit of the transformers is employed to charge the large glass condensers, which in discharging produce the high frequency oscillations thrown upon the aerial wire.

In addition to the spark gap method of generating high frequency oscillation in wireless telegraphy, as described in the foregoing, by means of induction coils, several other methods are now employed, namely, the Poulsen arc generator, the high frequency machine alternator and the three-electrode vacuum tube oscillator, to which reference will be found in article on (Wireless Telephony (q.v.). Consult Anderson and Elliott, 'Poulsen Arc' (*Electric Work*, 30 Aug. 1919); "Trans-Atlantic Radio Communication" ('Proceedings,' American Institute of Electrical Engineers, 1 Oct. 1919). Marconi has also developed a successful method of obtaining sustained oscillations by means of rapidly rotating metal discs which by suitable arrangements of capacities and inductances set up rapid charges in an oscillation circuit. For a description of this oscillator consult 'Transactions,' Royal Institution (London, March 1908) or Maver, 'Wireless Telegraphy and Telephony' (Part 2, page 9).

Syntony or Tuning.— An important defect of wireless telegraphy in the simple form thus far described consists in the fact that but one message can be sent at one time, for the reason that if it is attempted to send two messages at once in the same vicinity, the signals will clash. Many inventors have striven to overcome this defect, among others Lodge, Marconi and Slaby. The plan followed by these workers has been that of employing a syntonic or tuning method; that is, a method by which the transmitting and receiving circuits are adjusted or attuned to a fundamental rate of electric oscillations, to which rate of oscillations and no other the receiver so attuned will respond. This is done by taking advantage of the fact that the rate of oscillations, or the frequency of an electric circuit is proportional, as already noted, to the inductance, capacity and resistance of the circuit. Hence by varying the capacity or inductance of the tuning circuits any desired rate of oscillation is obtainable. Tuned circuits are termed selective circuits, since by sending out a given rate of waves any desired tuned circuit within signaling distance may be selected as the receiving station.

Tuning also possesses the advantage that the benefits of resonance may be obtained by its use as follows: It is known that a vertical wire grounded directly at its lower end is an excellent radiator of electric waves, but as it possesses very little capacity its oscillations are quickly damped as indicated in Fig. 11 and

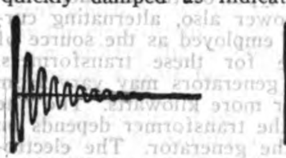


FIG. 11.—Quickly damped Radiator

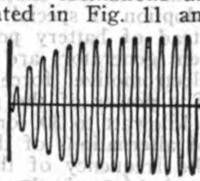


FIG. 12.—Persistent Radiator.

it is only the first few oscillations that are of sufficient strength to affect a receiver. When capacity and inductance are added to a circuit in certain proportions it may be made a persistent vibrator (Fig. 12) and consequently a given amount of electrical energy expended at the transmitter in producing a succession of waves of more uniform amplitude will have a cumulative or resonant effect upon a receiving circuit of equal capacity and inductance, and will eventually cause it to respond to the waves emitted by the transmitter; while an untuned receiving circuit containing a detector as sensitive as the first one, would probably not respond to those particular oscillations. In the case of tuned circuits, this is doubtless because the faintest oscillations, or electromotive forces, excited in the receiving circuit are resonantly amplified by the incoming waves of a selected frequency until they affect the detector.

As a rule, the spark-gap and the receiving apparatus of untuned circuits are connected directly to earth as indicated in Fig. 13, in which *A* is the antenna; *b b* are the spark balls or knobs; *s* is the spark-gap; *S* is the secondary

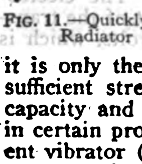


FIG. 13.—Open Circuit.

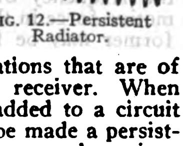


FIG. 14.—Closed Circuit.

and *P* is the primary of an induction coil or transformer. In such an oscillating circuit (*A*, *b*, *b*), the oscillations are quickly damped. In the case of tuned circuits, or where, at least, the effects of resonance are desired, there is provided a closed oscillating circuit which is separated from the vertical wire by a transformer. Such an arrangement is outlined in Fig. 14. The closed circuit in this case consists of the spark-gap, condensers *c c*, and the primary of transformer *T*. In practice the condensers and the inductance coils are made adjustable, so that the capacity and the inductance may be varied at will. Best results are obtained when the oscillating circuit and the vertical wire have equal fundamental oscillation periods; or when the one is a multiple of the other. Oscillating circuits arranged as in Fig 13 are said to be tightly coupled. When arranged as in Fig. 14 they are said to be loosely coupled.

In addition to the fact that the oscillations in an ordinary vertical wire are quickly damped, there is the further fact to be considered that the oscillations set up by a spark-gap transmitter are not continuous in the strict meaning of the word, since there is a perceptible time, while the oscillation circuit is being charged to the breaking down point of the air-gap, during which the oscillations tend to die out. Several inventors have striven to obtain a transmitter capable of supplying undamped or practically uniform oscillations to the oscillation circuit. Poulsen has developed some improvements in this direction by a modification of the Duddell singing arc (described in his British patent No. 21,629). (See TELEPHONY, WIRELESS). Briefly, it consists of an arrangement in which an arc lamp supplied by a direct current is placed in parallel with a capacity and an inductance. When the capacity and inductance are suitably chosen, rapidly alternating currents are set up in this arc which produce a tone — hence the name singing arc. In Poulsen's modification of this arrangement the negative electrode of the arc is carbon, while the positive electrode is copper, the arc being enclosed in a box containing hydrogen gas. The arc is shunted by a capacity and inductance and rapidly alternating currents are continuously set up which are thrown on to the vertical wire in the usual way. With the Duddell arrangement the frequency of oscillation was about 10,000 to 15,000 periods per second — too low for utilization in wireless telegraphy. A much higher frequency is obtained by the Poulsen arrangement which is attributable to the atmosphere of hydrogen. To further the cooling of the electrodes (an essential first noted by Elihu Thomson, in United States Patent No. 500,630), the copper electrode is made in the shape of a hollow ring through which water is passed. Tests have demonstrated that by this method of setting up undamped oscillations it is possible to signal to greater distances with much less electrical energy than is required with the spark-gap method.

Quenched Spark Transmitter.— Wein in 1906 discovered that very powerful discharges possessing advantageous properties for wireless telegraphy could be obtained from very short spark-gaps To avail of this discovery Von Lepel employed as an oscillation generator, a device consisting of a metal box having a partition of two copper plates separated by a very thin sheet of paper provided with a small aperture in its centre. The terminals of the usual charging electromotive force are each connected with one of the plates and the arc is formed at the small aperture between the plates, which arc slowly burns away the paper which must be renewed at intervals. The arc is shunted by the usual inductance and capacity. This arrangement produces very rapid quenching of the spark at the electrodes. Hence the primary oscillation circuit ceases to give out energy after the first blow, so to speak, while the secondary or aerial oscillation circuit continues to oscillate. It has been found in practice that with such rapidly damped primary oscillation circuits in coupled circuits, only one set of oscillations is radiated, whereas in less rapidly damped primary circuits the radiation of more than one set of radiations is not uncommon. Forms of quenched spark transmitters other than the Von Lepel arrangement have also been employed.

Electric Wave Meters.— It is very essential at times to measures the wave lengths or frequencies of wireless telegraph circuits. For this purpose a number of wave meters have been devised. These wave meters are based primarily on the fact that with an exciting current in proximity to a secondary circuit a maximum current will be induced in the secondary circuit when the two circuits are in resonance, which will be when they possess corresponding capacity and inductance. If the capacity and inductance of the secondary are known, the frequency and wave length are deducible. The period T of a complete electric oscillation varies with the inductance and capacity of the circuit, according to the formula $T = 2\pi\sqrt{KL}$ when T is the time in seconds, π is the ratio of circumference to diameter, K is capacity in farads and L the inductance in Henrys — or $T = 6.2832\sqrt{KL}$. Hence it is evident that the frequency n of the oscillations (number per second) will be equal to 1 divided by T; that is, $n = \frac{1}{T}$. The velocity V of propagation of the oscillations or waves being equal to that of light waves, 186,000 miles per second, the wave length then equals velocity divided by frequency $\frac{V}{n}$, or wave length equals,

$$T\ V\ \sqrt{KL} = 2\pi\ V\ \sqrt{KL}.$$

In ordinary practice resonance is indicated by the loudness of received signals in the telephone receiver.

One of the early wave meters, the Donitz, is shown in Fig. 15. A brief description of the device will explain the general principle on which wave meters operate. The Donitz wave meter consists of a coil of wire C, about eight inches in diameter that may be placed in the vicinity of the oscillation circuit to be measured, for instance, coil C' which may be a loop in an aerial circuit. Coil C is in series with a condenser K and another coil of wire c. c is in inductive relation to a smaller secondary wire W in the circuit of which is a small heat wire H, placed in one end of a U-shaped tube T, partly filled with a colored liquid. The capacity K consists of two sets of semi-circular metal plates, one set fixed, the other set movable to or from the fixed plates, the whole being contained in a glass case and immersed in oil. The movable plates are operated by means of a knob N to which is also attached a pointer P, which moves around a graduated scale S. The capacity K of this oscillation circuit varies with the

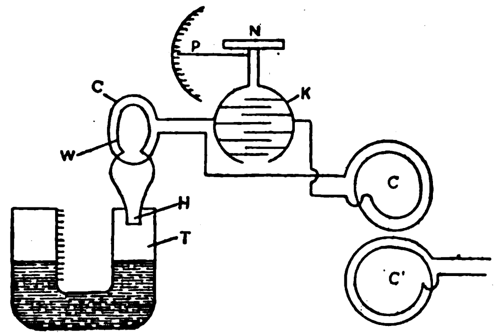


FIG. 15.— Donitz Wave Meter.

adjustment of the condenser plates. This capacity is then adjusted until the circuit is in resonance with the external circuit C', which will be indicated when the liquid in the left arm of the tube T is forced to a maximum height by expansion of the air or gas in the right arm of the tube due to heat wire H. At this time the pointer P will be opposite a given point on the calibrated scale that indicates the wave length or frequency corresponding to the inductance and capacity of the wave meter circuit at that time, which also corresponds with the frequency of the external oscillation circuit C'. Ordinarily the coil C' is placed concentrically within coil C. For more accurate results and to avoid reactance effects from coil C, the coils should be separated about one inch. If removed too far, the adjustment for resonance will not be so accurate. This wave meter is quite compact, the containing box being about one foot square.

Marconi's Tuned Wireless Telegraph System.— One early arrangement of Marconi's tuned or syntonic transmitting and receiving circuits is shown theoretically in Figs. 16 and 17. Fig. 16 represents the transmitting apparatus and circuits. In this A is the vertical wire in which is inserted a coil w, the number of turns of which, in use, may be varied by a sliding contact x. By this means the period of a vertical wire may be adjusted to correspond with that of the closed oscillating circuit p, c, b, b. The

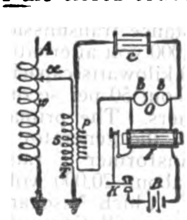


FIG. 16.

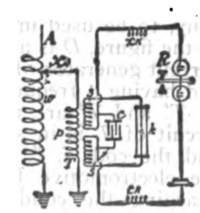


FIG. 17.

Marconi Tuned System.

condenser c, usually Leyden jars, of about .25 micro-farad capacity, may also be adjustable. I is an induction coil. K is a Morse key and B is a storage battery of five or six cells. The receiving apparatus and circuits are illustrated in Fig. 17. As in Fig. 16, A is the vertical wire, attached at its lower end to an inductance coil w. The coils p and s s constitute what is termed a "jigger," or hoister; it is in fact a type of "step up" transformer and is used to increase the efficiency of the apparatus by enhancing the electromotive forces acting upon the coherer; availing of the fact that there is a "node" of electromotive force and a "loop" of current at the foot of the vertical wire — that is, at that point the electrostatic energy is at minimum while electromagnetic energy is at maximum. *K* is the Marconi filings coherer, which is in series with the secondary coil *s s* of the jigger. A small condenser *c* is connected as shown, forming a short path for the oscillatory currents via the coherer, since for momentary currents the condenser is practically a conductor. *ck ck* are small choke coils (really inductance coils), which, being virtually opaque to rapid oscillations of current, direct the oscillatory currents across condenser *c*, thereby precluding any diversion of these currents through the relay *R*. This is a polarized relay of from 1,200 to 10,000 ohms resistance, in the circuit of which is a single cell *b*. The relay is usually inclosed in a cylindrical case to exclude dust. Some of the relays used for this work will respond to a current of $\frac{1}{20000}$ of an ampere. In practice this relay, the jigger, the coherer and tapper are enclosed in a metal sheathed box to prevent the action of external electric waves upon the coherer. For the same reason the local contacts of the relay and tapper are shunted with resistances, not shown in the figure. The Morse key employed is massive, with front and back contacts which are insulated from one another. It is provided with a large vertical ebonite handle to protect the operator against shocks. The use of the coherer for commercial use has been displaced by more modern devices.

The Fleming Long Distance Transmitting Circuit.— In Fig. 18 is shown diagrammatically

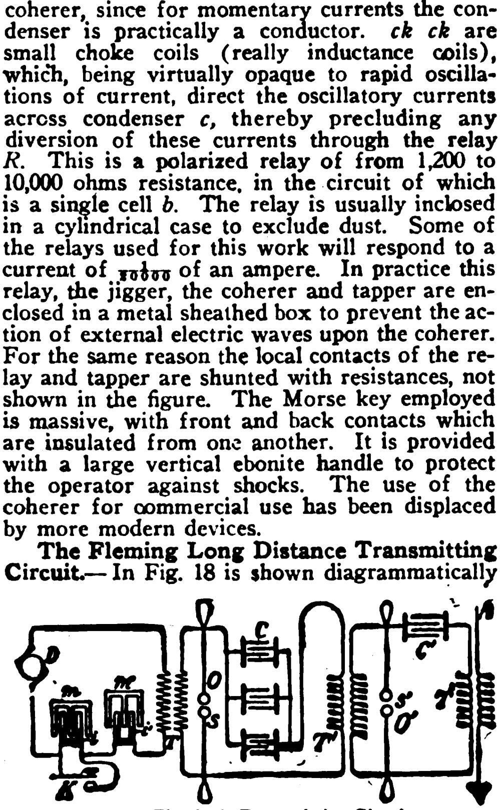


FIG. 18.—Fleming's Transmitting Circuits.

an arrangement, designed by Prof. J. A. Fleming for the Marconi Wireless Telegraph Company, to be used in long distance transmission. In the figure, *D* is a 500 or 1,000 volt alternating current generator of 10 or 20 kilowatts capacity, and having a frequency of about 50 per second. *T*, *T'* and *T''* are transformers. The primary circuit of *T* is in series with the generator *D*, and the coils *i*, *i'*. The transformer *T* raises the electromotive force to about 20,000 volts, charging the condensers *C*, which discharge across spark-gap *S*, setting up oscillations of a high order in the oscillating circuit *O*, *S*, *C*, *T'*. These oscillations are again transformed to higher voltage in the secondary of *T''*, which in turn charges condenser *C'*, and this, in discharging in the oscillating circuit *O'*, *S'*, *C'*, *T''*, still further increases the electromotive force thrown upon the vertical wire or wires *A*. The estimated electromotive force obtained at the vertical wire in this way is about 100,000 volts. These condensers are of glass immersed in oil and the transformers are of special construction to withstand these high pressures and to give the desired capacity and inductance. To avoid directly opening and closing the primary circuit of the transformer *T*, the two choke coils *i*, *i'*, having movable iron cores, *m*, *m'*, are placed in that circuit. The iron core *m'* of *i'* is so adjusted that as much current as may safely be passed through the primary of *T* shall normally flow in the circuit. The core *m* of *i* is inserted to its full length in the coil, and its inductance is sufficient to stop all flow of alternating current in the circuit. This coil may, however, be short-circuited by the key *K*, in dot and dash signaling, at which times the current attains its full value. Hence the circuit is not opened in the usual sense, but to avoid sparking the contact points of key *K* may be immersed in oil.

In Fig. 18a is shown theoretically a type of transmitting apparatus and circuits now employed in ordinary ship and land stations. *G M*

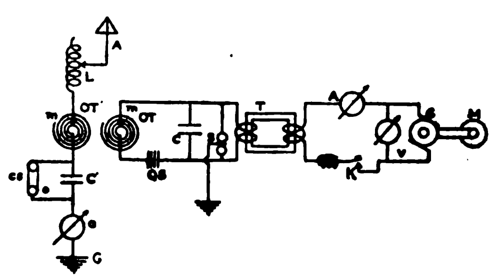


FIG. 18a.— Modern Transmitting Circuit. Land or Shipboard Station.

is a motor-generator controlled by a motor starter not shown. The motor is usually supplied with current at 110 volts pressure. The generator *G* may develop from 110 to 500 or more volts as desired. *QS* is the spark-gap (quenched gap type), *K* is a Morse key in the primary circuit of the transformer *T*. Specially designed keys for this work will open the circuit without excessive sparking with a current of 25 amperes and 110 volts. The voltage in the oscillation circuit *C*, *OT*, *QS*, may be raised to 10,000 volts or more by the transformer *T*. *C* represents a battery of Leyden jars or condensers. The oscillation circuit is connected by loose coupling to the aerial *A*, by means of oscillation transformers *OT*. The oscillation transformers in some cases consist of two independent coils of heavy bar copper wire with widely separated spirals and with one of the coils movable outside of the other for varying the coupling. Clips *m* are also provided whereby more or less of the coils may be connected in the circuit for tuning. *L* is a tuning inductance in the aerial. *C'* is a condenser used for short wave signaling. It may be cut out as in the figure by the switch *CS*. *A* is a hot wire ammeter placed in the aerial to show when oscillations are being thrown upon the aerial and to indicate the strength of current therein. Resonance is indicated between the circuits when the current in *h* is at maximum. *S* is a safety device designed to discharge excess current in the oscillation circuit to ground. A motor starting arrangement for the motor-generator is shown and described in the author's work 'Wireless Telegraphy and Telephony' (page 103).

Wave Motion, Directive Signaling and Direction Finders.— In ordinary wireless telegraph signaling the electric waves are radiated from the antenna in every direction, as, for instance, the light waves from a lamp on a pole are radiated in every direction. Attempts have been made to reflect and direct electric waves as light is reflected, but by means of metallic mirrors. These attempts were not successful owing to the difficulty in meeting the requirement that the diameter of the reflecting mirror must be large in comparison with the length of the electric wave to be radiated, and that the reflector must not be further than a quarter wave length from the oscillator or source of oscillations. This difficulty results from the great length of the electric waves used in wireless telegraphy and telephony. For instance, in the case of oscillations of 100,000 per second, over 9,840 feet. On the contrary the length of light waves is so infinitesimal that the smallest mirrors possible to construct, or even particles of air, are large by comparison with light waves. Some success has been met with in the matter of directive signaling by methods different from the mirror reflection method. Before describing some of these methods it may be not amiss to refer briefly to the theory of wave motion.

Wave undulations or oscillations of simple harmonic form are frequently shown graphically as a sinusoidal curve, or sine wave, derived, for example, from the motion of a point on the surface of a rolling wheel, or from the tracing made by the movement of a pencil point in a rectangular slot, under which a strip of paper is drawn with a uniform motion, the oscillatory movement of the pencil corresponding to a point moving back and forth along the diameter of a circle. In Fig. 19, the vertical lines *m n* may represent such a back and forth

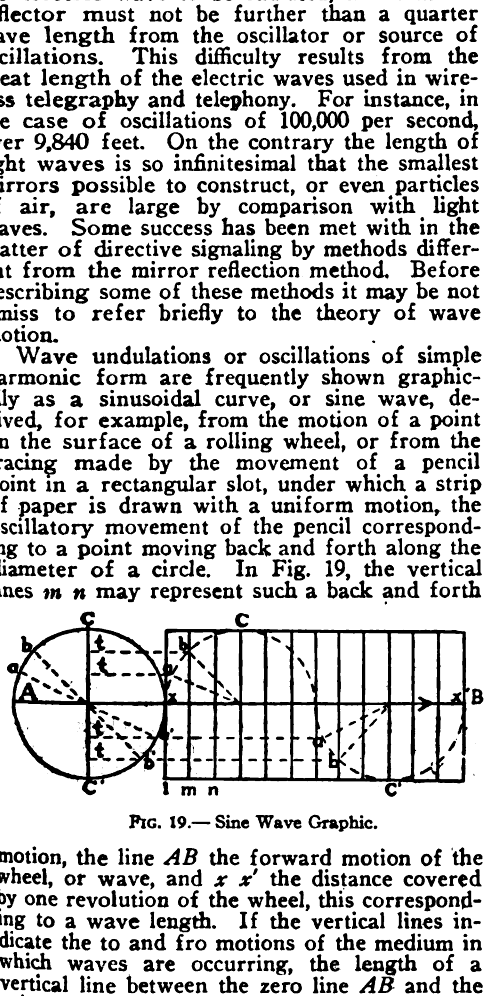


FIG. 19.— Sine Wave Graphic.

motion, the line *AB* the forward motion of the wheel, or wave, and *x x'* the distance covered by one revolution of the wheel, this corresponding to a wave length. If the vertical lines indicate the to and fro motions of the medium in which waves are occurring, the length of a vertical line between the zero line *AB* and the point of intersection of the curve will represent the extent of a motion of a given particle of the wave at a given point and instant. This is graphically shown by the horizontal lines *t* from vertical lines *C C'* in the circle, to points *b a; a' b'* on the curve. When used to represent an alternating current wave these lines indicate the strength of current or the *E.M.F.* at any given point and instant of the cycle. The period of a wave is the time taken by a particle to move from a given point, say, *x*, around the circle to point *x* again; or for the pencil point in the slot to perform one to and fro motion. On the solid horizontal line this as stated would correspond to the distance *x x'*. In wave motion it is understood that the particles of the medium do not move forward with the wave, but merely rise and fall like chips on the surface of a pond as the waves pass under them. As the wave progresses each particle of the medium in turn rises to the crest and drops to the trough of the wave. In an elastic medium it is assumed that the particle is displaced from its zero position by a force or strain which it resists with a counter force termed stress, the stress varying with the extent of the displacement, and tending to restore the particle to zero position. The position of a point or particle at a given instant relative to any fixed position is termed the phase, and the difference of position of a given point or particle relative to another particle during its motion over a circle is termed phase difference. Thus a particle at *b* will pass through point *C* in advance of particle *a*, the direction of motion being as shown by the arrow, and their phase difference when measured as an angle will be equal to the difference of the angles made by their radii with a fixed line *A x*. For example, the difference of phase between a particle at *C* and one at *x* is 90°, or one-quarter wave length; while a particle at *C* and one at *C'* will have a phase difference of 180° or one-half wave length. When two particles pass through the same point at the same time they have no phase difference. Any two particles one wave length apart are said to be in the same phase, and two waves of the same frequency whose corresponding parts are moving in opposite directions with the same velocity are said to have a phase difference of 180°. For present purposes the broken curved line in Fig. 19 may be considered to represent the contour of an electric wave, while that portion of the curve above the line *x x'* may represent an electric positive force or sign; that below the lines a negative force or sign, and the magnitude of the force of the wave at a given point and instant may be represented by the length of the vertical lines between *x x'* and their intersection with the curve. In this view, waves of different or equal phase and magnitude and agreeing or opposing in direction or sign may be caused to assist or neutralize one another, more or less; some instance of which will be given herein, and analogous instances of which may be found in textbooks on light and sound.

Electric Wave Localizer.— A device due to John Stone Stone for determining the direction from which wireless telegraph signals are emanating is shown in Fig. 20, theoretically. In the figure *V V'* represents vertical wires placed on a common axis *a*, and in series with which are coils of wire *x y* respectively. These coils are so wound that when oscillations of equal strength and direction simultaneously pass through them from wires *V V'* the coil *z*, which is in inductive relation to those coils, will not be affected. When the oscillations in coils *x y* are in opposite directions or differ in strength coil *z* will be affected. Coil *z* is in series with detector *d*, condenser *C* and telephone receiver *t*. In order to obtain the maximum effects of the wave energy the wires *V V'* in this arrangement are placed the distance of half a wave length apart, which distance can be ascertained by means of a wave meter. Assuming the length of the arriving waves to be

50 feet, the wires 25 feet apart, and that their plane is in the line of motion of the advancing wave, the wires will receive the waves at a phase difference of 180° or half a wave length. Hence the oscillations in the wires due thereto will be of equal strength, say, 10, as indicated in the figure, but opposite in sign, or direction, in coils *x y*, and the coil *z* will be inductively affected to a maximum extent. If the wires

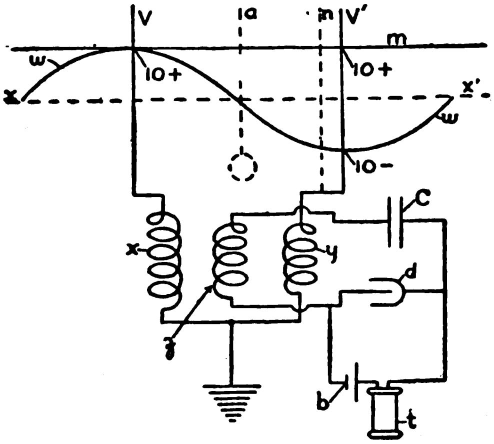


Fig. 20.— Stone Localizer.

are so moved that the distance between them is less than half a wave length the sign in the respective wires may still be opposite, but the strength in each will not be equal. Thus, if wire *V'* is moved to the point indicated by dotted line *n*, the force of the wave at *V* will still be 10+, while at *V'* it will be less than 10— and the oscillation current strength in coil *x* will be greater than that in coil *y*, and detector *d* will be energized. Or keeping the wires half a wave length apart, but rotating them on the axis *a* until this plane is perpendicular to the front of an advancing wave having at a given instant a force of, say, 10+, it will fall on both wires as indicated by line *m* where the force and sign are equal. Oscillations of equal strength and direction will then be set up in the vertical wires, the effect of which on the coil *z* is nil, owing to the differential winding of the coils *x y*. To determine then, the direction of arriving waves it is only necessary to turn the wires *V*, *V'*, on their axis *a* until the combined forces of the oscillations in coils *x y* upon *z* are zero which will be when the plane of the wires is at right angles to the direction of the arriving waves. According to Mr. Stone the apparatus of this device has never been used with a wave length exactly twice the distance between the two aerials or vertical wires *V V'*. The object in having the wave length equal to twice the said distance is that such an arrangement gives maximum intensity of signals, the signals under all conditions being a maximum when the plane of the waves is at right angles to a plane down through the two antennæ; the signals being canceled in the coils *x y* when the plane of the waves is parallel with the plane passing through the vertical wires. Consult U. S. Patent No. 716,135, 1902, covering this device.

Bent Antennæ in Directive Wireless Signaling.— De Forest states that by using a vertical wire to which is attached a pivoted horizontal wire signals are received by means of the detector in the vertical wire, the strength of which signals appear to vary according as the position of the wires approach or depart from a position of parallelism with the direction of travel of the waves. The various arrangements of *T* and *L* antennæ so largely employed for capacity on shipboard and in land stations correspond more or less to the foregoing device but practical experience does not definitely indicate that in ordinary shipboard working the signals are affected favorably or otherwise as regards the directive effect on signaling by such arrangement of the aerial wires.

Marconi has made numerous experiments relative to directive wireless signaling and has found that by placing a large number of wires, arranged as an *L* aerial, or bent antennæ, and with the open end pointing away from the distant station the direction of effective radiation may be largely controlled; also that by using a similar antennæ the reception of signals is much improved. Braun, Artom and others have also experimented with directive wireless telegraph devices, an account of which may be found in textbooks on wireless telegraphy.

Bellini-Tosi Directive Wireless Signal System and Direction Finder.— These inventors began their experiments in France, using a triangular nearly closed aerial circuit capable of rotation on its axis, using a transmitter and receiver somewhat similar to those already described. Like other experimenters Bellini and Tosi found that the strength of received signals was a maximum when the plane of the triangular transmitting circuit was placed in the

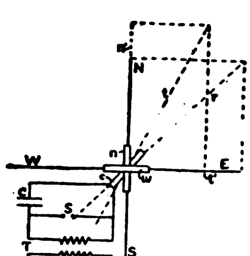


Fig. 21.

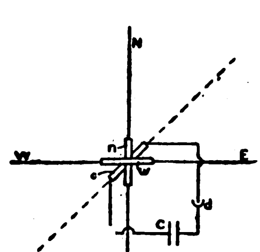


Fig. 22.

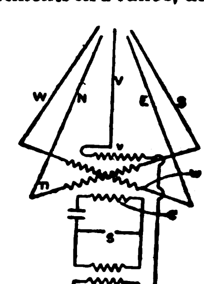


Fig. 23.

Bellini-Tosi Direction Finder. Using Goniometer.

direction of the receiving station, and that upon turning the triangle on its axis directing its plane away from that station the strength of signals gradually weakened and was always zero when the plane was at right angles to that station. To avoid the difficulties involved in the use of movable aerials for directive purposes the inventors devised the plan of using two sets of triangular aerials, placed at right angles to one another, as outlined in Figs. 21, 22, 23 in which *W E* indicate the two upper sides of one triangle and *N S'* similar sides of the other triangle. In connection with this arrangement of aerials a device termed a radio-goniometer *n w C* is utilized in which will be seen a certain resemblance to the Stone localizer previously described. The radio-goniometer consists of two fixed coils *n w* at right angles to one other, and of a central coil *C* movable on a pivot in any direction within the coils *n w*. When used for transmitting, the coil *C*, Figs. 21, 23, is the primary of an oscillation transformer with two secondaries, *n w*. When used for reception of signals, as in Fig. 22, coil *C* becomes the secondary of two primaries *n w*. The fixed coil *n* is connected with aerial wires *N S*; fixed coil *w* with aerials *W E*. When the device is used as a transmitter, if it is desired to transmit signals in the direction of the plane, of say *N S*, the primary coil *C* is turned on its pivot until it is parallel with coil *n*, at which time inductive effects will be inappreciable in coil *w*, but will be a maximum in coil *n*, and the direction of transmission will be *N S*. If the primary coil be placed parallel with coil *w* the direction of radiation will be *W E*. If it is desired to send signals in any direction between *W N* or *E S*, this is effected by placing coil *C* in the desired position in which case each coil *n w* will be acted upon proportionately to its angle with coil *C*, and the direction of radiation will be a resultant due to the combination of the two electromagnetic forces developed by the coils *n w*, virtually according to the law of the parallelogram of forces. In Fig. 21, for instance, with coil as shown, the resultant direction would be as indicated by the dotted lines *r*. The length of the thick lines *N E*, respectively, represent the assumed magnitude of the component forces in the direction indicated by those lines; or if the coil *C* be turned in the direction of dotted or resultant line *t*, the magnitude of the component force due to coil *w* would be reduced by the amount indicated by the intersecting dotted line at *t'*, while the component force due to coil *n* would be indicated by the dotted line *n'*. Reversely when the radio-goniometer is used as a receiver or direction finder, Fig. 22, the incoming wave fronts will fall on the closed aerial oscillation circuits, virtually as stated in connection with Fig. 20. Thus if an arriving wave front is in the plane of *N S*, coil *n* only will be affected and coil *C* is turned bv the operator until maximum current or signals are obtained. If, on the other hand, the wave front is advancing from a direction midway between *N* and *E*, the coils *n w* will be equally affected and the best position for coil *C* will be as indicated by the dotted line *n* in Fig. 21. The foregoing described device derives added importance from the fact that it forms the basis of the now well-known Marconi-Bellini-Tosi Direction Finder. (Consult Weagent, 'Static Eliminator'). This and other direction finders are likely to be of great utility in enabling the navigators of air ships to obtain their bearings when in fogs, etc., etc. For example, assuming that certain land stations are instructed to send out prearranged signals, the navigator by means of a direction finder on his ship can quickly ascertain his direction.

Statics and Atmospheric Interference in Wireless Telegraphy.— Marconi found during his experiments that daylight was inimical to long distance wireless telegraphy. In other words, that signals could be received at a much greater distance at night than in the daytime. It is supposed that this is because ionization of the air is greater in daylight than at night and that the ionized air of the atmosphere absorbs more or less of the long waves employed in trans-oceanic wireless telegraphy. Marconi observed that the effect of ionization of the atmosphere was not noticeable to an injurious degree at distances less than 500 miles.

It has long been known that atmospheric electricity can be drawn from points above the earth's surface by means of a wire upheld in the air. This is due to the fact that the upper layers of the atmosphere are statically charged with electricity to a point of electric potential differing from that at the earth's surface. The grounded aerial wire tends to equalize this difference of potential and currents of electricity discharge through it to earth. The aerial wire used in wireless telegraphy similarly acts as a medium of discharge for atmospheric electricity, and in so doing produces currents of electricity that have been the source of much interference with the operation of wireless telegraphy and telephony. This particular source of external interference can be measurably obviated by disconnecting the wireless aerial from the cable. Lightning storms and snow-storms also set up interference, but they do not constitute a very serious obstacle to the operation of wireless telegraphy. The foregoing and other electrical disturbances encountered in wireless telegraphy, are known under the general names of «statics,» «X's» or «strays,» and certain types of such disturbances have hitherto made the successful operation of trans-oceanic and long distance wireless telegraphy generally, very difficult. The effect of the discharge of atmospheric electricity by way of the aerial wire to earth is termed «hissing.» Other types of static interference are termed respectively «clicks» and «grinders.»

An electrical source of interference due to «strays» or electromagnetic waves, probably caused by variations in the electrical condition of the atmosphere, produces disturbances in the wireless receiving apparatus sufficient to render signals unreadable while the disturbances last. These effects are very pronounced in the tropics and are much less noticeable in winter than in summer or temperate zones.

A number of devices have been used to partially eliminate the effects of statics, the most common being the placing of a small air gap in the aerial wire, across which the static currents pass, thereby diverting them from the receiving apparatus. For short distances this device is of use.

To avoid static effects, Fessenden devised the plan of divided circuits shown in Fig. 24.

A is the aerial. *B B'* are branched circuits from the aerial, coupled differentially, to a detector circuit *C, C, C*. *T* is a head telephone receiver. The assumed operation of this device was that if one of the branch circuits, say *B*, be attuned to arriving signals and the other branch, *B'* be not so attuned, the attuned circuit would respond to arriving signals while the untuned branch would not so respond, and, further, that the static currents, being forced vibrations, would pass through both branches in equal strength and would, therefore, cancel each other in the differented coils. It has been pointed out, however, that the static currents are also responsive to tuning of the branches to different rates of oscillation which prevents the desired cancellation of the static currents in *B B'*, hence the static noises will be heard in the receiver. Consequently, any apparent benefit derived from this arrangement must be due to the loose coupling of the circuits, which diminishes the strength of the static currents.

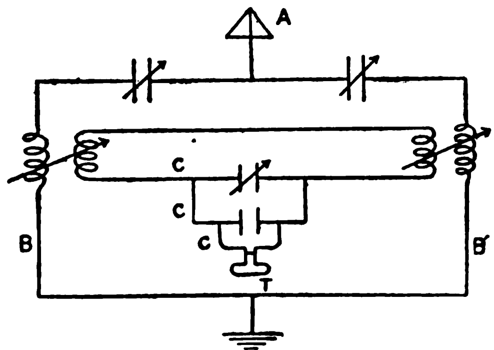


FIG. 24.— Fessenden Interference Preventer.

Dieckman designed a protective shield of wires to be placed over and around the wires of an *L* antenna to cut off the static currents from the aerial and divert them to the earth. This device is expensive since it practically duplicates the regular antennæ, but it largely diverts atmospheric currents from the aerial proper. It does not, however, divert horizontal electromagnetic strays from the antenna.

Weagent Anti-Static Device.— The principle involved in this device is the outcome of Weagent's remarkable discovery that the statics producing the greatest interference in wireless telegraphy are not parallel with the waves due to radiation from wireless telegraph stations, but are vertical in direction. It is beyond the scope of this article to give more than a brief description of the methods which Mr. Weagent has invented to avail of this discovery. For a full description thereof the reader is referred to the Journal of the Institute of Radio Engineers, March 1919.

Granting the accuracy of Mr. Weagent's assumption as to the vertical direction of static currents or waves the direction of their propagation will be at right angles to that of advancing wireless telegraph waves. The problem was then to separate the wireless signal waves from those due to statics in the antenna circuit.

The Weagent arrangement of circuits and apparatus to effect this result is shown theoretically in Fig. 25, the explanation of which will perhaps be simplified by reference to the description of the Stone Direction Finder, and the Bellini-Tosi goniometer, herein. For his purpose Mr. Weagent arranged two loops *L L'* of aerial wires supported on poles, the receiving station being at *X*. The length of each loop is, say, three miles, although the inventor has

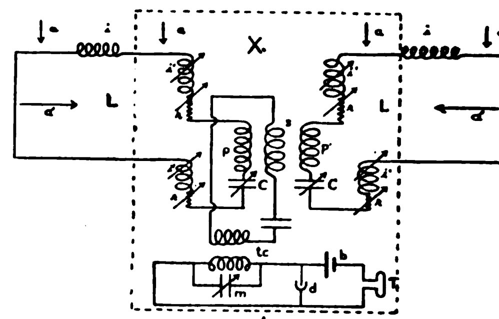


FIG. 25.— Weagent Anti-Static System. Two-Wire Aerials.

experimented with loops of varying lengths less than three miles. The sustaining poles are 30 feet high. The wires of the loops are spaced 15 feet apart on the poles. Each loop is connected at *X* in series with a condenser *C* and one primary coil *p, p'* of a radio goniometer, the secondary coil *s* of which in turn is coupled with the tuning coil *tc* of a wireless receiving circuit containing the usual variable condenser *m*, detector *d*, battery *b* and telephone receiver *T*. Variable inductances *i'* and resistances *r* are placed in the loops *L L'* for adjustment purposes. The coil *s* may be rotated into a desired position.

The vertically moving static waves are indicated by the downward arrows *a a*, the electromagnetic waves due to wireless signals are indicated by the horizontal arrows *a' a'*. Since the static waves cut both of the loops simultaneously the currents set up by them in the primary coils *p p'* of the goniometer (being wound oppositely to each other) are in phase and produce no effect on the secondary coil *s* of that apparatus. But the arriving signaling waves cut the respective loops at different times with the result that the currents set up thereby are not in phase and a preponderating current is produced in one or other of the primary coils of the goniometer, which induces a current in the secondary *s* of those coils that is heard in the detector circuit as in ordinary wireless telegraph operation.

Mr. Weagent in his paper states that to obtain tuning in the loops an inductance coil *i, i* of 30 millihenrys is placed in the upper wire of each loop and best results are obtained when this inductance is placed near the middle, when the tuning is at a maximum. A similar coil placed in the lower wire of a loop effects no change in tuning. Experiments showed that a coil of 30 millihenrys was best for a wave-length of 12,000 meters while a coil of five millihenrys gave best results for a 6,000-meter wave. Both values, however, were satisfactory for either length of wave with loops three miles in length.

While the foregoing device was efficacious in getting rid of the vertical statics termed grinders, it was found, in long-continued tests made by Mr. Weagent with a two-wire aerial system installed at Lakewood, N. J., that the interference due to clicks or horizontal waves could not be altogether eliminated by the two-wire loop arrangement. Mr. Weagent defines the interference termed grinders as that which produces in the telephone receiver a continuous rattle with occasional crashes, and it is more noticeable in warm than in cold seasons. On the other hand clicks, which are widely spaced crashes in the telephone, are more noticeable in cold weather, but they are not so continuous in their action as grinders. For instance, it was found that with the two-wire loop arrangement clicks interfered materially with the reception of signals emanating from such comparatively low power stations as Clifden, Ireland, and the Eiffel tower, and that any plan devised to reduce the effect of the clicks also weakened the signals. On the other hand the clicks were not of sufficient strength unduly to impair signals received from the more powerful stations at Carnarvon, Wales, or Nauen, Germany.

By means of another device due to Mr. Weagent and shown in Fig. 26, it became possible to eliminate the statics due to clicks to the extent that the signals from the weaker European stations were easily readable. Since it was demonstrated by the experiments referred to that the two-loop aerial picked up vertical static waves and horizontal electromagnetic waves, Mr. Weagent conceived the idea of utilizing the two-loop aerial as a tank or receptacle for the static waves that produce grinders and clicks, and then avail of these waves at a given instant to balance out by suitable means the practically similar waves developed in a third aerial that would constitute the receiving circuit proper in the manner now to be described.

In Fig. 26 *SL SL* comprise the two-wire aerial tanks for this purpose. The instruments and circuits at the receiving station are indicated within the dashes. The receiving aerial proper is the long horizontal wire *L L*, which is suspended on the same poles as the tank aerials *SL SL*. The function of *SL SL* as intimated is to accumulate and supply at a desired instant currents due to grinders and clicks which by suitable adjustment of a goniometer *S*, *P*, *P'*, and of the inductance coils *i'*, resistances *r* and condensers *C* shown, are made to neutralize or balance the static and click currents picked up by the receiving aerial *L*, *L*, before reaching the vacuum tube detector circuit *A*. The rotary goniometer coil *S* is coupled to the detector circuit *A* at *a'* and to the receiving aerial *L L* at *a*. Circuit *A* is also coupled to the receiving aerial *L* via *a'* and *a*. This device allows the current signals from distant stations to be received at normal strength and without static or click interference, during all hours of the day.

It is claimed by Mr. Weagent that continued use of his static eliminator has shown beyond question that its performance is not occasional or accidental, but is reliable and consistent. With this system of reception trans-Atlantic radio telegraphy can now be carried on free from interruptions caused by statics of any kind, excepting only that due to local lightning. Further, the barrier in the way of radio telephony is by means of this system also removed, inasmuch as statics have interfered with radio telephony to a much greater extent than with radio telegraphy. Improvements have been lately perfected by means of which radio messages may be successfully received from across the Atlantic Ocean, with apparatus, including the entire equipment, and miniature aerials, so comparatively diminutive that they may be placed on a lecture platform.

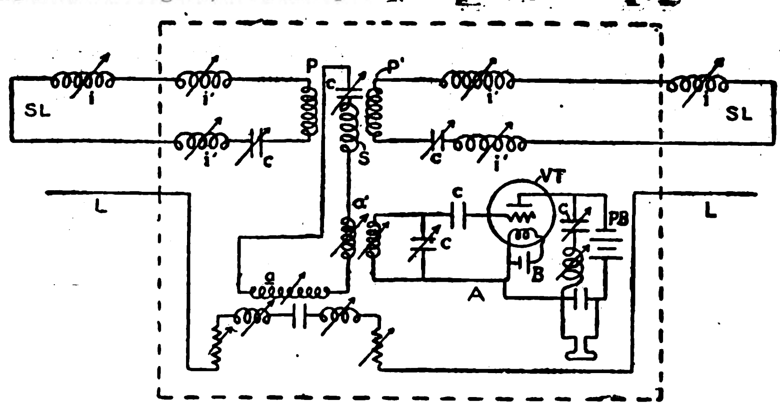


Fig. 26.— Weagent Three-Wire Aerial·Static Eliminator System.

Comments on Trans-Atlantic Wireless Telegraphy.— The Great War interfered materially with the free use of wireless telegraphy and during the term of the war the governments of the various nations of the world exercised complete control of its operation over land and sea. The following remarks concerning the status of trans-Atlantic Wireless telegraphy are drawn from an article in the 'International Cable Register Supplement,' by E. B. Pillsbury.

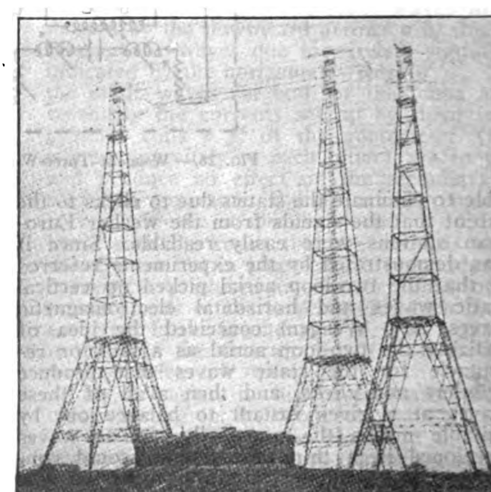
"Regular message traffic has been transmitted between Europe and America by Wireless telegraphy continuously for over eight years by means of a duplex circuit between Clifden, Ireland, and Glace Bay, Cape Breton, that is, messages between those points are transmitted in either direction simultaneously. The transmitting and receiving apparatus are not placed in one station but in separate stations a number of miles apart, connected by land lines, which make it possible to localize the sending and receiving operators in the one room. The receiving instruments are coupled to two distinct aerials, one of which is used for receiving, while the other, known as the balancing aerial, is so arranged that it is practically unaffected by the signals from the distant station from which it is expected to receive. The effect produced by the balancing aerial on the receiving apparatus by the adjacent transmitter is equal and opposite to that produced thereby through the receiving aerial which is tuned to the wave-length of the signals it is desired to receive. The latest type of the Marconi receiving apparatus greatly minimizes the atmosphere interference to which wireless transmission over long distance was particularly exposed in the early days. The signals arriving in Glace Bay from Clifden are as a rule easily read through any ordinary electric atmospheric disturbance. The strengthening of received signals has made possible the employment of recording instruments which not only give a permanent record of the received messages, but are also capable of operation at a much higher rate of speed than would be obtainable by an operator receiving by sound or sight. The method employed for this purpose is to insert into a gramophone the wireless telephone whereby the received dot and dash signals are impressed on the wax cylinder. These signals may thus be recorded at maximum speed and afterward be removed to another gramophone that may be speeded down to the capacity of the receiving operator. A high rate of transmission of signals is attained by the used of a Wheatstone automatic transmitter (see TELEGRAPHY) using perforated paper tape.»

While the war has interrupted the free use of wireless telegraphy and telephony it has at the same time made demands upon the engineers of this country and Europe in the direction of improvements in these arts that have no doubt produced practical results that would not otherwise have been forthcoming in years. This has been remarkably true with regard to the improvements in vacuum-tube apparatus and the results obtained thereby in the service of the United States Signal Corps. For this service alone the production of high quality standardized tubes has been at the rate of over 1,000,000 per annum. For interesting data on this subject consult a lecture given by Maj.-Gen. George O. Squier before the American Institute of Electrical Engineers, 10 Jan. 1919, on «Aeronautics in the United States from the Beginning of the War to the Present Time.»

The Marconi Wireless Telegraph Station at Belmar, N. J.— The building shown in the foreground is the operating-room of the station. It is over 82 feet in length. This station is intended to communicate with the high power station at Carnarvon, Wales. The masts shown are 300 feet in height and extend westward one mile from the shore. The room containing the tuning apparatus is over 80 feet long. The messages received and transmitted from this station are sent to and from the Marconi offices in Broad street, New York, by automatic telegraph apparatus. Similarly, messages are received and transmitted from the Marconi office in London to the high power station at Carnarvon.

Marconi Wireless Station at Belmar, N. J.

Proposed Pan-American Wireless Chain of Stations.— It has recently been announced that the largest wireless station in the world is to be constructed near Buenos Aires, South America. This will be one of a series of wireless stations designed to connect the United States with all the important countries of South America, including Argentina, Brazil, Uruguay, Chile, Peru and Ecuador. Mexico and Cuba are also to be placed in wireless communication



It is understood that the lofty towers from which the aerials will be swung in the South American station will be of the self-supporting type, somewhat similar to the Arlington towers here illustrated.

with these countries. The South American wireless system will connect at New York with trans-Atlantic wireless to Great Britain, Scandinavia and Russia and at San Francisco with the Hawaiian Islands and thence with the Orient. In the United States the system will connect with the 25,000 stations of the Western Union land lines.

The aerials of the proposed station at Buenos Aires will be supported by self-supporting towers corresponding to the towers of the powerful station at Arlington, Va., which are illustrated in the accompanying illustration. Further details of this projected chain of wireless stations will be found in *The Wireless Age* (August 1918).

Bibliography.— Proceedings of Institute of Radio Engineers; Bucher, E. E., 'Practical Wireless Telegraphy' and 'Vacuum Tubes in Wireless Communication'; Fleming, 'Principles of Electric-Wave Telegraphy'; ib., 'Elementary Manual of Radio Telegraphy and Radio Telephony'; Maver, William, Jr., 'Wireless Telegraphy and Telephony.'

WILLIAM MAVER, JR.,
Author of 'American Telegraphy.'

TELEKI, Samuel, COUNT, African explorer: b. Saromberke, Eastern Transylvania, 1845; d. March 1916. He won a distinguished place on the roll of African explorers by his expedition of 1886–89, during which Lake Rudolf, fourth in size of the great lakes of Equatorial Africa, was for the first time sighted by white men. The existence of a great lake in the unknown area between the Victoria Nyanza and Abyssinia had for some years been rumored, and after the route in this direction had been opened up by Joseph Thomson's journey through Masailand, Count Teleki was the first to take advantage of this open road. He not only made his way to the lake, but traced it to its northern extremity, bringing back valuable observations on the geography, geology and ethnology of the country traversed. He made various subsequent journeys in Africa and the East, but resulting in no further geographical discovery.

TELEMACHUS, tĕ-lĕm'a-kŭs, in the Homeric Trojan War cycle, a son of Ulysses (q.v.) and Penelope. He was still in the cradle when his father went to the Trojan War. When his father had been absent from home about 20 years, Telemachus was urged by Athēna (Minerva), who appeared to him in the guise of Mentor, a friend of Ulysses, to go and seek him; and as the place of his residence and the cause of his long absence were then unknown, he visited the courts of Nestor and Menelaus to obtain information. He afterward returned to Ithaca, where the suitors of his mother, Penelope, had conspired to murder him; but he escaped their treachery. His father had arrived in the island two days before him, and was then in the house of Eumæus, a faithful swineherd. Telemachus is the hero of Fénelon's famous romance 'Les Aventures de Télémaque' from which the word "Mentor" has been adopted into proverbial use. See TÉLÉMAQUE.

TELEMACHUS, a Syrian monk, who, in the time of the Emperor Honorius, about 400 A.D., leaped into the arena of the Coliseum and attempted to separate the gladiators. He lost his life at the hands of the enraged populace, but the occurrence is said to have influenced Honorius to discontinue gladiatorial combats, which he did soon afterward.

TÉLÉMAQUE, a romance by Fénelon. 'Télémaque' is in form a novel, and relates the adventures of Telemachus in search of his father, Ulysses. In its flowery poetic style, however, and in its division into 24 books, it suggests the epic poem rather than the modern novel. It is based upon the Odyssey of Homer, and uses the mythology and introduces many of the characters of that poem. Its intention was primarily didactic. It was one of several works that Fénelon wrote for the instruction of the young Duc de Bourgogne, grandson of Louis XIV, whose tutor he was (1689–95). By his experiences and observation during his wanderings, in various lands and among different peoples, aided especially by the wise comments and interpretations of Minerva, who accompanies him in the form of Mentor, the young Telemachus, future ruler of Ithaca, and through him the future ruler of France, received those lessons on the proper conduct of life and especially on the duties of a king and on sound principles of government, which were calculated to prepare them for the responsibilities of their high stations. It is a striking mark of the honesty and independence of Fénelon that these lessons are singularly liberal and modern, and contain implicitly a sweeping indictment of the government and policies of Louis XIV. 'Télémaque' has often been translated into English. ARTHUR G. CANFIELD.

TELEMETER, any one of various instruments designed to measure the distance of objects more or less remote. It is used by surveyors and engineers, where rapid work is necessary and a fair amount of accuracy required, on the battlefield to determine ranges, etc., where it is usually called a range-finder. One form is a recording apparatus electrically connected with a distant meteorological or other instrument. The surveyor's telemeter is better known as a stadia, and consists of a mounted telescope with horizontal cross-wires, which, when in use, intercept the divisions upon a graduated rod held by an assistant at the distant point. The reading multiplied by the "factor" of the instrument gives the distance.

TELEOCEPHALL, that is, (Gr. τέλεος) complete (Gr. κεφαλ'η) head. A name applied by some authorities to a group of fishes embracing most of the teleosts, or true bony fishes, especially those bearing a full complement of cranial and opercular bones, with the anterior vertebræ separate.

TELEOLOGY (Greek, *telos,* "end" or "purpose") denotes a mode of explanation in accordance with which the world as a whole, or particular forms within it, are regarded as due to the realization of some end or purpose on the part of some intelligence existing either in the world or outside it. Thus we might account for the various arrangements of the physical universe — the distribution of land and water, the movements of the heavenly bodies, the changes of the seasons — by referring them to some end that the governing power of the universe is thereby achieving, as, for example, the preservation and comfort of mankind. Or we might explain the structure of an organism or of any of its parts by reference to the purpose that it serves, as, for example, the presence of fish in the sea through their usefulness to man as food, or the structure of the eye through the actual service that it renders. It is natural to assume that everything has been made for man and to regard all things as existing for his service and convenience, that «even the cork-trees,» as Hegel remarked in satirizing this view, «have been produced in order that we may have stoppers for our bottles.» Teleology does not always adopt this narrowly anthropocentric point of view. But the very essence of its procedure is to postulate the existence of some intelligible ends or purposes in the world, and to read the various natural phenomena by reference to these ends. It is thus explanation in terms of final causality, rather than in terms of efficient causes or mechanism. Teleology seeks to make things intelligible by showing their relation to an end that is being realized; it answers the question «Why?» or, «For what purpose?» Mechanism, or explanation by efficient causes, on the other hand, knows nothing of a purpose. It shows how the result has actually been produced by the operation of natural causes, acting according to invariable laws. It explains by answering the question «How?» It is well known that there has been a constant conflict, throughout the whole history of thought, between teleological and mechanical modes of explanation. Indeed, this may be said to be the supreme question at issue in all philosophy. Is the world and all that it contains merely the natural product of efficient causes acting without any intelligent guidance, or is there some purpose or system of purposes being realized?

The terms in which the conflict between teleology and mechanism are expressed have been modified in recent times, and it is perhaps well to note some fundamental differences between the thought of the present time and the earlier mode of conceiving teleology. The older teleology regarded God (or the gods) as a being outside of the world who in an external way was accomplishing some purpose through it, as the mechanician uses a machine to accomplish his purposes. From the modern point of view, God is identical with the ultimate principle of things. The purpose of the world, if any intelligible purpose exists, is not something superimposed on it from without, but an inner or immanent purpose to which it naturally and everywhere gives expression. The general acceptance of the modern doctrine of evolution, with its natural explanation of organic forms and modifications, at first appeared to overthrow teleology. For it was from the phenomena of organic life that the defenders of the older teleology had drawn their strongest proofs. Living forms and processes did not seem explicable by mechanical process, and here, at particular points, it was supposed one could trace the operation and determining influence of the teleological factor. The Darwinian theory doubtless destroys the possibility of conceiving teleology as a particular influence that occasionally intervenes at special points in the process of the world, superseding and doing the work of efficient causes. But modern thought has come to realize that the end or purpose is not something that operates here or there, at particular points, but as immanent principle is the underlying basis of the world-process as a whole. In other words, there is no conflict between teleology and mechanism — between explantation by means of final and that by means of efficient causes — when the proper sphere and limitations of each are understood, but it is rather true that as mutually complementary conceptions they presuppose each other. Modern teleology admits to the full the rights of mechanical explanation in every field. But it insists that the facts of experience and the nature of our intelligence demand that we shall everywhere go beyond this standpoint and recognize an underlying system of purposes in the world-process. The two modes of explanation are thus on different planes, and opposition between them only arises from failure to recognize this fact. As Lotze says: «The true source of the life of science is to be found in showing how absolutely universal is the extent, and at the same time how completely limited the significance of the mission which mechanism has to fulfil in the structure of the universe.»

Both a mechanical and a teleological view of the world was developed by Greek philosophy, the former by the Atomists, of whom Democritus is chief, the latter mainly by Plato and Aristotle. The influence of the latter thinkers, united with the general spirit of the Christian doctrines, made the teleological the prevailing mode of explanation during the Middle Ages. The pioneers of modern thought,— Galileo, Bacon, Descartes, Gassendi, Hobbes, Spinoza — worked out anew the mechanical theory, making it a powerful instrument of research by basing it on exact mathematical principles. They were strongly opposed to teleology, which they regarded as entirely unable to furnish scientific explanations of natural occurrences. Leibnitz was perhaps the first thinker in modern times who saw that teleology and mechanism can be reconciled by properly distinguishing the planes where each principle has its valid application. For Kant (whose treatment of teleology is very important), mechanism is the only principle that we can confidently apply in science as objectively determining phenomena. Teleology, on the other hand, although a necessary subjective thought when we are dealing with organic phenomena, cannot be affirmed to have objective application. Living things must appear to us as if they were determined by some end, but we can never say that this purpose is actually present outside our minds in the objective phenomena themselves. At the same time, while mechanism is and must remain the sole principle of determination in the phenomenal world, Kant teaches that we are obliged to postulate a world of noumenal or more ultimate reality where teleology, by recognition of a moral purpose in the world, becomes the final determining principle. (See also MECHANISM). Consult Adler, Max, 'Kausalität und Teleologie im Streite und die Wissenschaft' (in *Marx Studien*, Vol. I, Vienna 1904); Bosanquet, B., 'Meaning of Teleology' (in 'Proceedings' of the British Academy, London 1906); Erhardt, Franz, 'Mechanismus unde Teleologie' (Leipzig 1890); Janet, Paul, 'Final Causes' (Eng. trans. by W. Affleck, New York 1883); Windelband, 'History of Philosophy'; Höffding, 'History of Modern Philosophy'; Spinoza, 'Ethics' (Appendix to Part I); Kant, 'Critique of Pure Reason' (latter part of 'Transcendental Dialectic'); 'Critique of Judgment' (Second Part); Shoup, 'Mechanism and Teleology' (1891).

J. E. CREIGHTON,
Professor of Philosophy and Dean of the Graduate School, Cornell University.

Fig. 1 — Oscillograph Record Showing Changes in the Electrical Current when the word "New York" is spoken into the Telephone

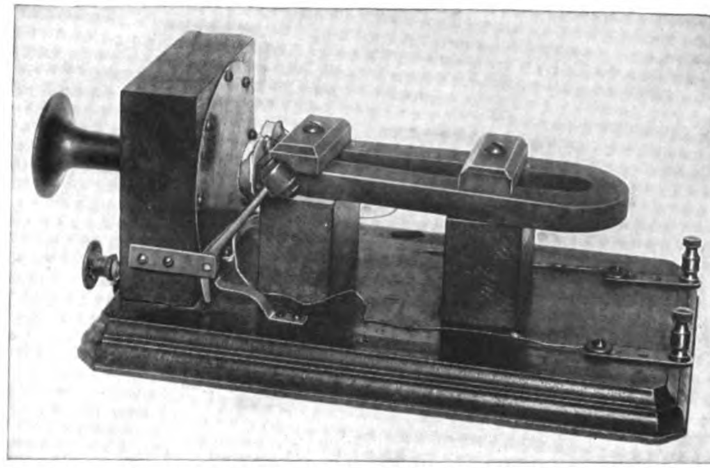


Fig. 11 — **Box Telephone. Cover Removed. Made in June, 1877. Equipped with a sheet iron Diaphragm and the Watson Hammer Signal or "Thumper." First form of telephone equipped with a signalling or calling device. This instrument was used interchangeably as transmitter and receiver**

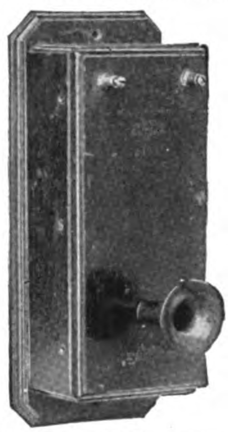


Fig. 15 — **Bell Box Wall Telephone, August, 1877, with pole-pieces and mouthpiece at right angles to the magnet. This first commercial form of wall telephone was used both as transmitter and receiver**

Fig. 10 — **Box Telephone. First Style**

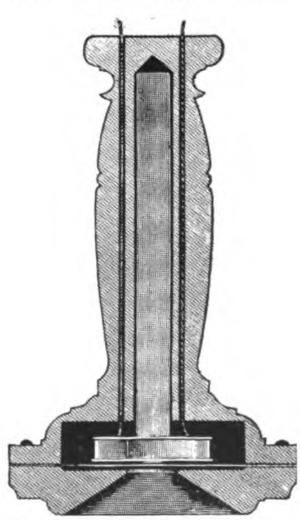


Fig. 12 — Cross-section of Wooden Hand Telephone made in May, 1877, frequent y called the "Butter Stamp" receiver. First commercial form of Bell Hand Telephone. Used both as a transmitter and receiver

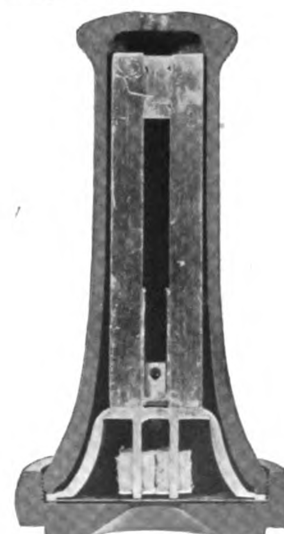


Fig. 14 — Cross-section of modern Bi-polar Receiver

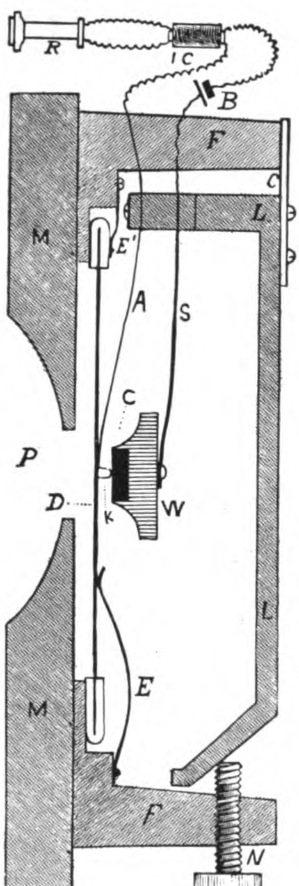


Fig. 18 — Cross-section of Blake Transmitter

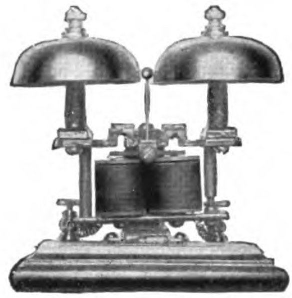


Fig. 24 — Magneto Telephone Ringer or Call Bell, invented by Thomas A. Watson in 1878. Used in the first commercial Bell subscribers' sets

Fig. 29 — Modern Desk Set with automatic switchhook

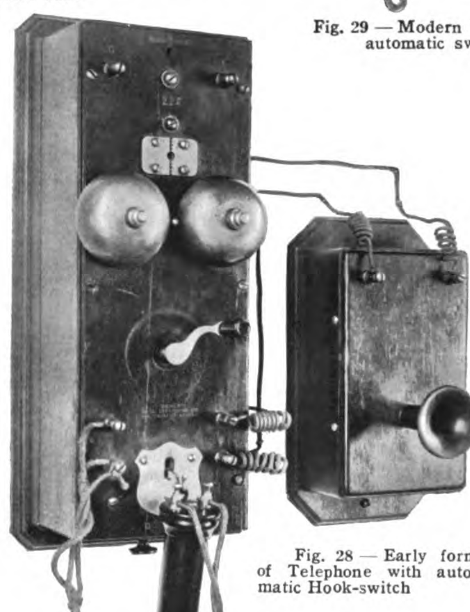


Fig. 28 — Early form of Telephone with automatic Hook-switch

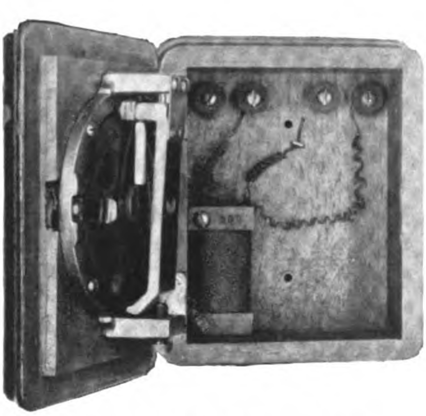


Fig. 19 — Blake Transmitter, open

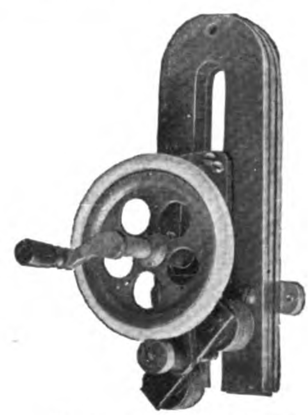


Fig. 25 — First Magneto Telephone Generator. Designed by Thomas A. Watson in 1878

would do the same for any sound, even that of speech, this experiment revealed to him the possibility of accomplishing the desired results. The next day he gave instructions for the making of his first real telephone, known as the «Gallows» type. (Fig. 4). It consisted of a framework carrying an electro-magnet with its reed armature, the free end of which was attached to the centre of a small drumhead of gold-beater's skin. A mouthpiece was provided

FIG. 5.— The Liquid Transmitter. The first instrument to transmit a complete articulate telephone message.

for speaking purposes. With this instrument, speech sounds were transmitted over a short line and heard by means of a second instrument of like character. From this time on, many forms of receivers and transmitters were experimented with until, on 10 March 1876, the first articulate complete sentences were transmitted. Professor Bell was then experimenting with his liquid transmitter. (Fig. 5). This instrument consisted essentially of a diaphragm, capable of being vibrated by the voice, to the centre of which was attached a small conduct-

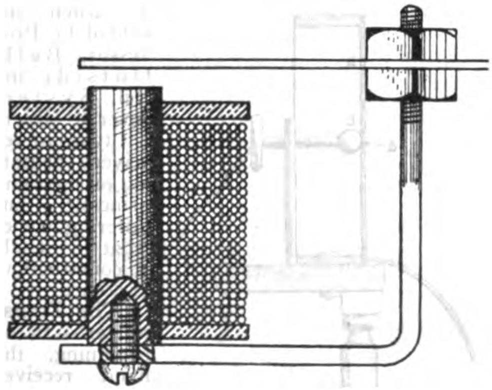


FIG. 6.—Cross-section of Bell's Tuned Harmonic Receiver.

ing rod dipping into acidulated water contained within a small cup. A large flaring mouthpiece was provided and the whole was suitably mounted on a frame and base with connecting terminals. This transmitter was connected in series with a battery and a tuned harmonic receiver. (Fig. 6). Undulating current was produced by the change in resistance of the circuit as more or less of the rod was immersed due to the vibration of the diaphragm. With these instruments, Professor Bell speaking, and Mr. Watson listening, the first complete articulate telephone message was transmitted.

On 9 Oct. 1876 the first reciprocal conversation took place over an outdoor line, two miles long, between Boston and Cambridgeport, Mass. The instruments (Fig. 7) had, as diaphragms,

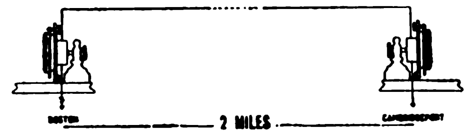


FIG. 7.—Circuit and instruments used by Professor Bell, 9 Oct. 1876. The first time that satisfactory and sustained conversation was carried on by electrical means between persons miles apart.

thin iron discs which responded to the voice vibrations. Close to, but not touching, the centre of the diaphragm was the core of an electro-magnet, the windings of which were connected in series with a battery, the line and a similar instrument at the other end. With these instruments was carried on a sustained conversation which was fully reported in the next morning's papers as the latest startling scientific achievement.

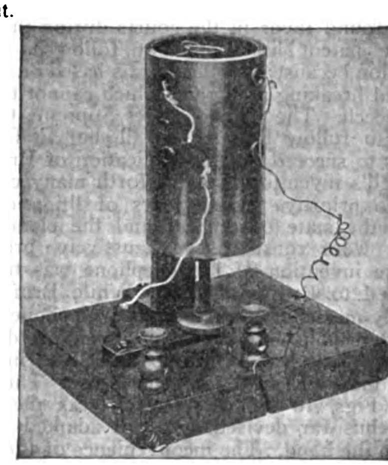


FIG. 8.— Bell's Centennial Iron Box Receiver, 1876.

Professor Bell exhibited his telephone inventions at the Centennial Exposition in Philadelphia in 1876. There he demonstrated, before the judges of the exposition and a large number

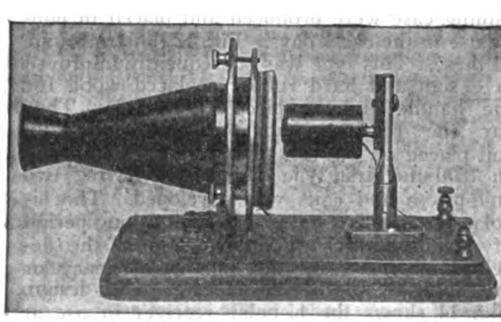


FIG. 9.— Bell's Single Pole Membrane Telephone. Demonstrated before the judges at the Centennial Exposition, 25 June 1876. This instrument was used as a transmitter, the receiver used being the Iron Box instrument shown in Fig. 8.

of people, his liquid transmitter (Fig. 5); iron box receiver (Fig. 8); single pole membrane telephone (Fig. 9), and other types of instruments. As a result of this exhibition of the telephone its fame spread rapidly.

Work of Early Investigators Preceding Bell.— The idea of applying electricity for the transmission of sound arose as soon as the effects of electric telegraphy were observed. Page, in 1837, discovered that a magnetic bar could emit sounds when rapidly magnetized and demagnetized. Electric vibrators devised by Macaulay, Wagner and Neef and adapted to produce musical sounds by Froment and Petrina in 1847 to 1852, showed that the transmission of sound to a distance was not impossible. Bourseul, in 1854, suggested that if one spoke near a movable disc sufficiently flexible to lose none of the vibrations of the voice, this disc, by alternately making and breaking the current from a battery, might cause another disc, at a distance, to execute the same vibrations simultaneously. Reis, in 1870, invented a musical telephone that, by alternately making and breaking an electric circuit, could transmit musical tones over a wire to a distant point. Reis' work, although urged as an anticipation of Bell, never found favor in the courts during the extensive patent litigation that followed Bell's invention because his scheme was based on making and breaking a current, which cannot transmit speech. The United States Supreme Court said «to follow Reis is to fail, but to follow Bell is to succeed.» The publication of Professor Bell's invention brought forth many claimants to priority. After years of litigation in which the state of the art and the claims of others were considered exhaustively, priority for the invention of the telephone was finally awarded to Professor Bell. While Professor Bell, by means of lectures on the telephone, was arousing public interest in his invention, development work was begun to make the instruments more practical for general use. The box type (Figs. 10 and 11), which was the best form thus far devised, was not adapted to be held in the hand. The inconvenience of the box telephone led to the development of a style of instrument which could be held in the hand readily and used for transmitting or receiving as desired.

The Receiver.— Several forms of receiver (hand telephone) employing wood for the containing case were produced and placed in public use in the early days. Fig. 12 illustrates one of these. This type was subsequently improved in design and hard rubber replaced wood for the handle and ear-piece. (Fig. 13). Thus far the receiver had one pole-piece and coil placed on the end of a permanent magnet. In 1890 the first type of receiver having two pole-pieces and coils was developed. The bi-polar receiver has passed through a long period of evolution, each successive step in the development increasing its talking efficiency or improving the mechanical features of its design. Fig. 14 shows the bi-polar receiver in use at the present time in the Bell System. Two permanent magnets are used. To their poles are welded soft iron pole-pieces which constitute the cores of the electro-magnetic coils. The supporting cup, of non-magnetic material, is welded to the magnets and cores, thus forming a rigid unit which is mounted within a hard rubber case and ear cap. The latter clamps the diaphragm firmly in place close to, but not touching, the pole-pieces. Every part is made of carefully selected material, manufactured to extremely accurate dimensions, and the whole is assembled and tested with the utmost care in order that instruments of the greatest attainable efficiency and mechanical strength may be secured. In all, over 50 different types and styles of receivers have been developed for use in the Bell System. Practically all of these have been abandoned in favor of the latest improved type. While great improvements have been made in the design and efficiency of the telephone receiver, its fundamental electrical principle is the same to-day as when invented by Professor Bell. Outside the Bell System several different types of receivers operating on the same principle, but differing somewhat in details of construction, are used.

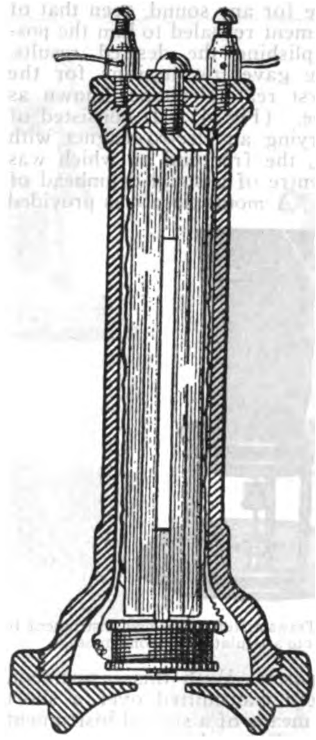


Fig. 13.— Cross-section of improved Hand Telephone, with hard rubber handle and ear-piece.

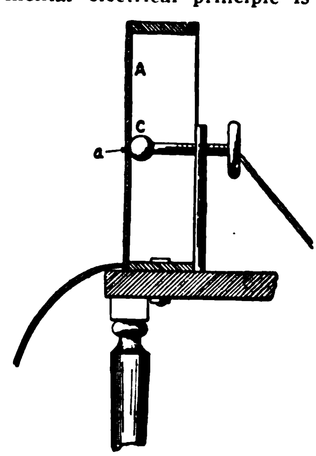


Fig. 16.—Early form of Berliner Transmitter.

The Transmitter.— In the beginning, the hand receiver type of instrument was also used as a transmitter. This was shortly developed into the magneto box transmitter. (Fig. 15). Except for very short lines, this magneto type of transmitter was not sufficiently powerful. The solution of the vitally important problem of improving this part of the telephone system grew out of the invention of the variable contact resistance transmitter.

In 1877 Emile Berliner inverted a transmitter (Fig. 16) having, in contact, two pieces of metal; one stationary, the other capable of being vibrated by the voice. The principle was this: with two bodies in contact and forming part of an electric circuit, if the pressure on the contact be increased, the electrical resistance of the circuit is diminished and more current flows, whereas, if the pressure be diminished the resistance increases and less current flows. In the figure, *A* is a metallic diaphragm capable of being vibrated by the voice. This diaphragm at its centre is in contact with a metal ball *C*. The essential contact is at *a*. Vibration of the diaphragm, as explained above, causes corresponding undulations in the current flowing in a circuit including the contact, a battery, the line and the receiving instrument. In later forms of the Berliner transmitter, carbon contacts were employed instead of metal.

In 1877 Edison invented a transmitter (Fig. 17) in which the current varying element consisted of a small disc of carbon (lamp black) placed between two plates so arranged that the vibration of a diaphragm varied the contact pressure.

In 1878 Francis Blake invented an important improvement in contact or microphone transmitters. He employed a platinum point

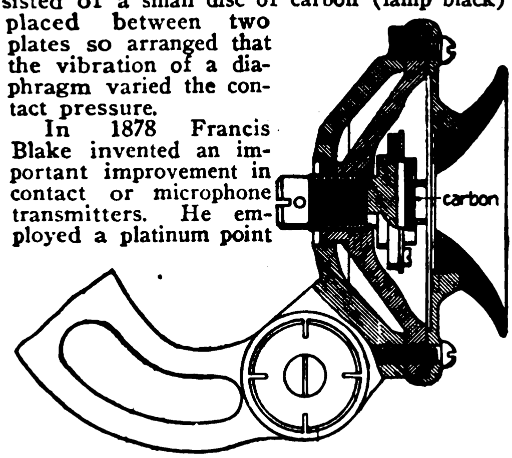


FIG. 17.—Cross-section of Edison Carbon Transmitter. Later type.

bearing against a hard carbon surface. Fig. 18 is a cross-section of a Blake transmitter. The platinum point *K* is borne by a light spring *A*. The hard carbon disc *C*, mounted in a brass cup *W*, is supported by a substantial spring *S*. The platinum and carbon are first brought into light contact with each other after which the platinum point is forced against the diaphragm centre under considerable pressure from spring *S*. The commercial form of this instrument

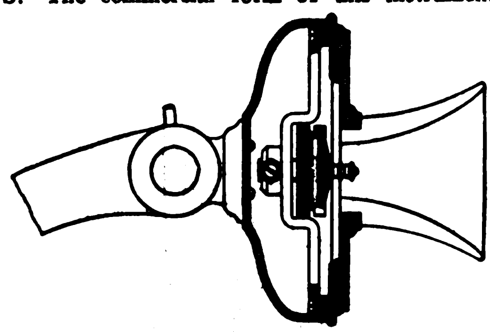


FIG. 21.—Cross-section of modern Solid Back Transmitter.

(Fig. 19) displaced the Berliner and Edison types and was extensively used for a long time as the Bell System standard.

In 1880 an English clergyman, Henry Hunnings, invented a transmitter employing granular carbon to secure a large number of points of microphonic contact. The essential feature was a thin platinum diaphragm in contact with a mass of granular carbon enclosed within a chamber having at the rear a plate of metal or carbon in contact with the granular carbon. In 1885 Bell engineers improved the Hunnings transmitter (Fig. 20) by using a horizontal platinum diaphragm *A* and a gold-plated electrode *C* dipping into the granular carbon. While this transmitter operated well when at its best, after being used for some time the large quantity of granular carbon produced an insensitive condition that seriously affected its efficiency.

To overcome this, A. C. White, in 1890, working in the Bell laboratories, invented the solid back transmitter (Fig. 21) in which the contact element is in the form of a small chamber (termed the "button") containing two carbon disc electrodes; one fixed, the other free to vibrate. These electrodes are separated by a small space partially filled with granular carbon. The fixed electrode is rigidly supported by the solid backing afforded by a stout metal bridge. The movable electrode is firmly attached to the centre of the diaphragm. The function of the granular carbon is the same as in the Hunnings type but the defects of the latter are overcome. This instrument has proved so perfect in its operation and so satisfactory in its general design that it has formed the basis of all the best types of transmitter. A number of modifications from the original design have, however, been made to improve its electrical and mechanical features. Fig. 22 shows the construction of the "button" of the modern common-battery solid back transmitter. Over 70 different types and styles of transmitter have been developed and placed in service by the Bell system. Practically all of them have been displaced by the type just described. Transmitters employed by independent companies operate on the same general principle as the type just

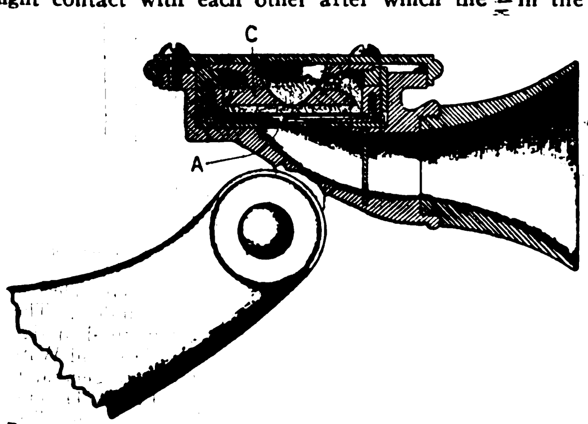


FIG. 20.—Cross-section of early form of Long Distance Transmitter.

described and resemble it in appearance.

The Induction Coil.— Coincidently with the introduction of the variable contact (microphone) transmitter came the application of the induction coil to the telephone. Fig. 23 shows

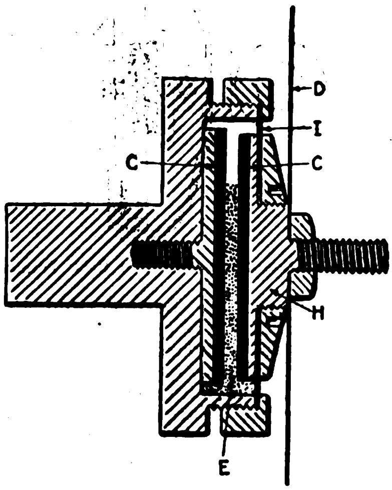


Fig. 22.— Cross-section of Granular Button or Cell for Solid Back Transmitter.
D. Diaphragm. H. Plunger.
C. Carbon facing of cell. E. Granular material.
I. Flexible ring of mica, closing joint between plunger and cell walls.

the original telephone circuit and two important steps in the evolution of telephony whereby it became possible to talk over greater distances than formerly. In the simple magneto telephone circuit *A*, the amount of electrical energy transmitted depended on the ability of the telephone, when spoken into, to generate a current independent of any outside source. This current was limited in strength to the small amount obtainable from the vibration of the diaphragm by the voice. *B* in Fig. 23 shows a circuit in which the variable contact transmitters, the receivers, the line and the source of

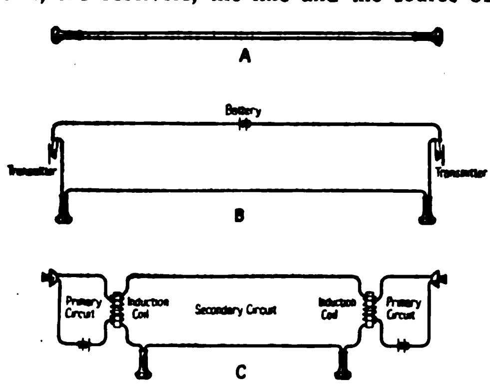


Fig. 23.— Three steps in the evolution of the telephone circuit.

energy (battery) were connected together in series. With this arrangement better results were obtained, the extent of improvement depending on the voltage of the battery, the conductivity of the line and the current changing capabilities of the transmitter. In this circuit the transmitter acted as a valve to vary the energy furnished by the battery. *C* in Fig. 23 shows the use of the induction coil, the latter consisting of a bundle of iron wires surrounded by two separate wire windings. Each transmitter is placed in series with a battery and the primary winding of an induction coil consisting of a few turns of large wire. The secondary winding of the induction coil, consisting of many turns of relatively fine wire, is connected in series with the line and the receivers. Placing the transmitter in a local circuit, independent of the line circuit, permitted the use of a low voltage battery and allowed the variation in resistance produced by the transmitter to be large in comparison with the total resistance of the primary circuit. The induction coil operates as a transformer. The relatively large variable current at low voltage in the primary circuit is transformed into a small current at high voltage in the secondary circuit by reason of the large ratio of the number of turns in the secondary winding to those in the primary winding. The secondary current traverses the line with less loss than would be the case if the current were of lower voltage but larger.

Signalling Systems.— When the box telephone was first employed, the custom was to tap on the diaphragm with a pencil as a method of calling the party at the other end of the line. Later this was superseded by a hand-operated hammer mechanism which gave a vigorous blow on the diaphragm that was transmitted telephonically to the station at the other end of the line (Fig. 11). Tap bells were also em-

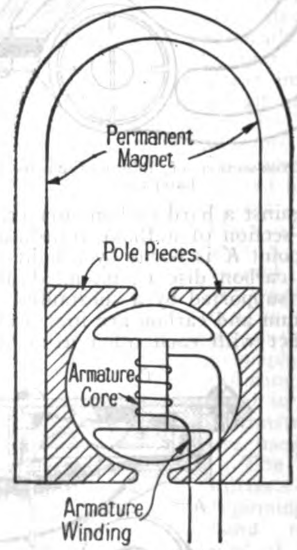


Fig. 26.—Diagram of Magneto Telephone Generator.

ployed for signalling as were ordinary electric vibrating bells and telegraph sounders. The need for a reliable and efficient method of signalling was realized at an early date and Watson developed a ringer and magneto-generator to meet this need. The ringer (Fig. 24) consisted of an electro-magnet having a centrally-pivoted polarized armature carrying the striker which played between two gongs. Polarizing the armature made it responsive to the reversals in polarity of the magnet when alternating current passed through the coils of the latter. To furnish the alternating current, a small magneto-electric generator (Fig. 25) was provided, consisting of a powerful permanent magnet carrying an armature capable of being rotated by a wheel which the calling party turned by means of a crank. Figs. 26 and 27 show, in diagrammatic form, the principles of the latest types of generator and ringer.

Automatic Switchhook.— It was early apparent that some means should be provided for switching, to and from the line, the signalling and talking circuits at the substation whenever it was desired to do so. At first, hand-operated switches were used for this purpose but it was

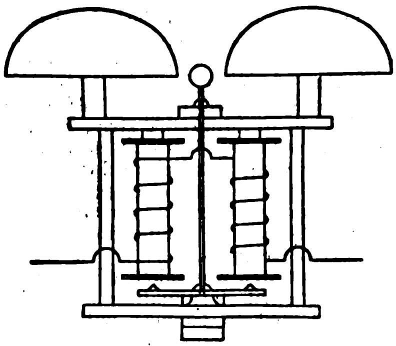


Fig. 27.—Diagram of Magneto Telephone Ringer.

soon found desirable to make the switching operation automatic, as users would frequently leave the hand-operated switch in the wrong position. To attain this end, a lever switch upon which to hang the receiver was invented by H. L. Roosevelt. The switch was operated by the weight of the receiver. Fig. 28 shows an early set arranged to accomplish the desired purpose. The hook-switch, in its downward position, left the circuit free for the incoming signal; in its upward position, which it assumed when the receiver was removed from it, the necessary contacts for talking were closed. Figs. 29 and 30 illustrate the switchhook arrangement for the present telephone. Figs. 31 and 32 show the circuits controlled by the switchhook for a standard magneto and common-battery substation circuit respectively.

Series and Bridging Bells.— In the early days, after the development of the magneto-bell, or "ringer," it was the practice, on party lines, to connect the sets in series, as shown in Fig. 33. To enable the ringer to operate effectively it was necessary to provide it with a large num-

Fig. 30.— Switchhook for Modern Telephone, showing contacts.

ber of turns of wire. As a result these ringers possessed considerable impedance, i.e., they offered substantial obstruction to the telephone

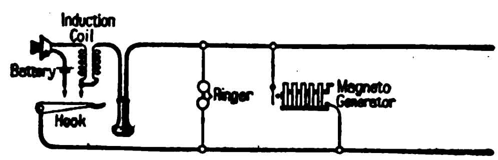


Fig. 31.—Magneto Substation Circuit.

current, seriously affecting the service between any two talking stations. The more ringers in the circuit, the poorer was the talk. To improve

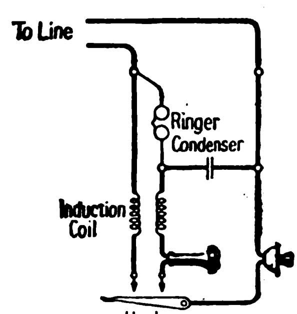


Fig. 32.—Common-Battery Substation Circuit.

this condition, in 1889, John J. Carty, who at that time was known as one of the chief technical experts, and who has since become the rec-

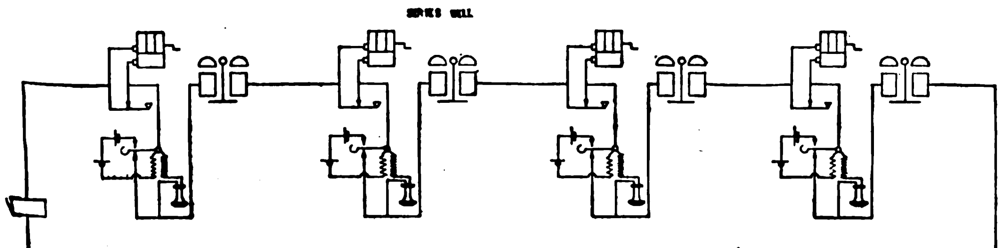


Fig. 33.—Party Line Circuit with Series Bell.

ognized engineering leader in telephony, invented the bridging bell. In this arrangement (Fig. 34) the bell, or "ringer," has a high impedance winding which, while responsive to the relatively low frequency ringing current, does not permit the talking current to pass over the ringer circuit, but does allow it to pass over the line from one station to another. It was this invention which made possible the successful use of party lines.

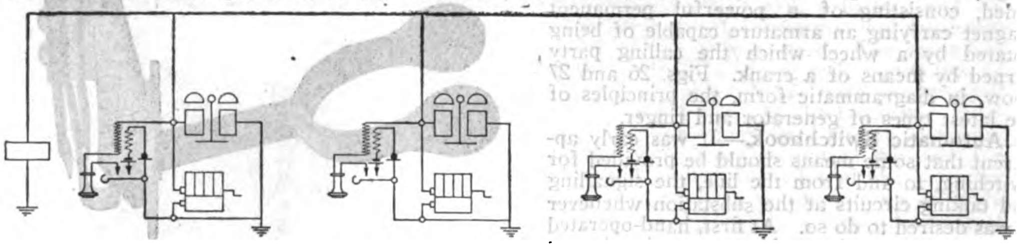


FIG. 34.—Party Line Circuit with Bridging Bell.

Switchboards.— If its use had been restricted to isolated lines only, the telephone would undoubtedly have remained scarcely more than an interesting scientific curiosity. With the development of the instruments themselves, the necessity for connecting one telephone station with another, by means of some switching device, at once became apparent.

The first interconnection of telephone lines by means of a switchboard took place at Boston in 1877. A few burglar-alarm lines were equipped at the station ends with box telephones. At the burglar-alarm office, each line was connected to a small metal block. These blocks were so arranged, in relation to other metal blocks placed closely beside them, that metal plugs could be employed to connect the blocks together in various ways, thus permitting the lines to be interconnected as desired. (Fig. 35).

The first commercial switchboard was installed at New Haven, Conn., in January 1878. (Fig. 36). This small board accommodated only a few lines. It did away with the block and plug method of connection, substituting, for the latter, pivoted strips of metal adapted to be rotated into contact with metallic buttons, all being mounted on a wooden board. Each line was connected through the pivot, with one of the rotatable metal strips. Every other line was connected with a metal button, these buttons being so placed, around the circumference of a circle, that, by rotating the strip, connection could be made with any desired button and line.

Shortly following this, many different types of switchboards were made employing either plugs or button switches in various arrangements for making the connections. Fig. 37 shows one of these types.

An important step was taken when the flexible connecting cord, terminating at each end in a plug, adapted to connect with any line, was adopted as a substitute for the hand switch described above. Fig. 38 shows an early type of board employing connecting cords. In this style of board each subscriber's line was provided with an electromagnetic annunciator the shutter or index of which moved, when a subscriber operated the magneto-generator at his station, thus attracting the operator's attention to the fact that a connection was desired. Each subscriber's line was also connected at the

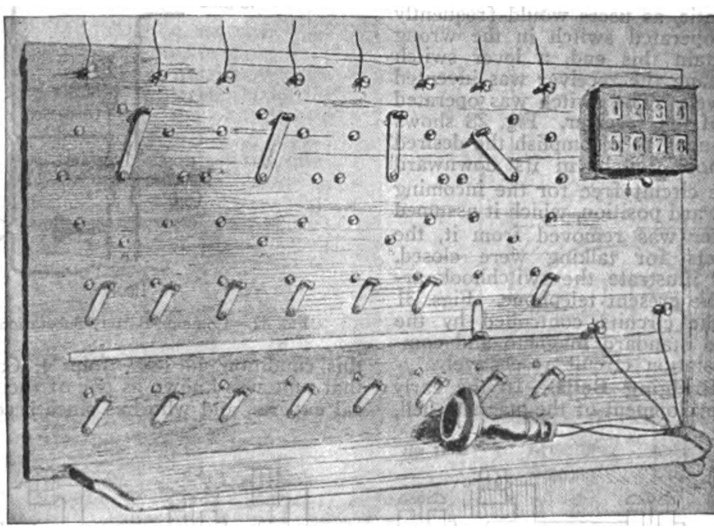


FIG. 36.—First Telephone Switchboard. Used in New Haven, Conn., for eight subscribers.

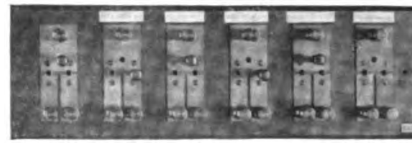


Fig. 35 — Arrangement used at Boston to connect together Burglar-Alarm Lines

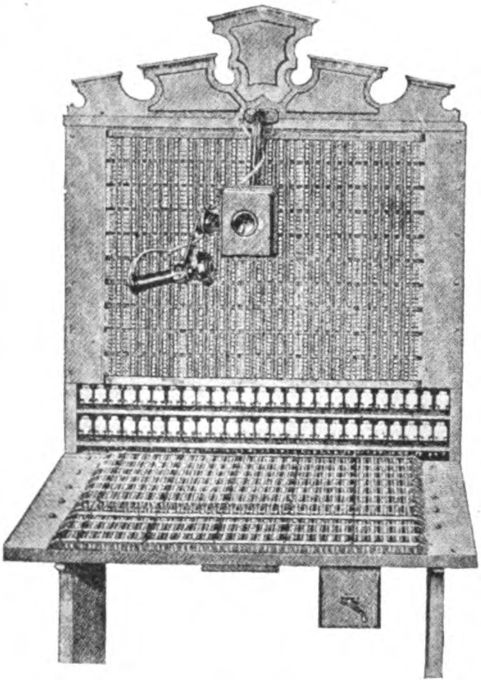


Fig. 37 — Early form of Switchboard

Fig. 44 — Subscriber's Set usel with Automatic System

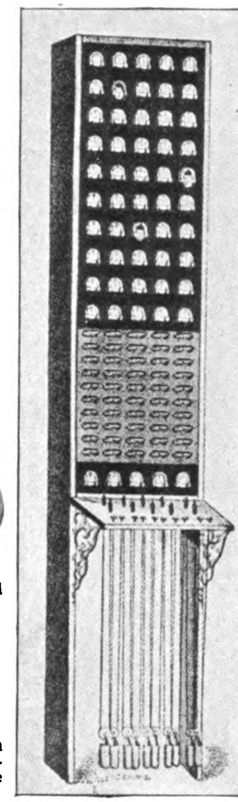


Fig. 38 — Early form of Switchboard with Flexible Cords for making the connections

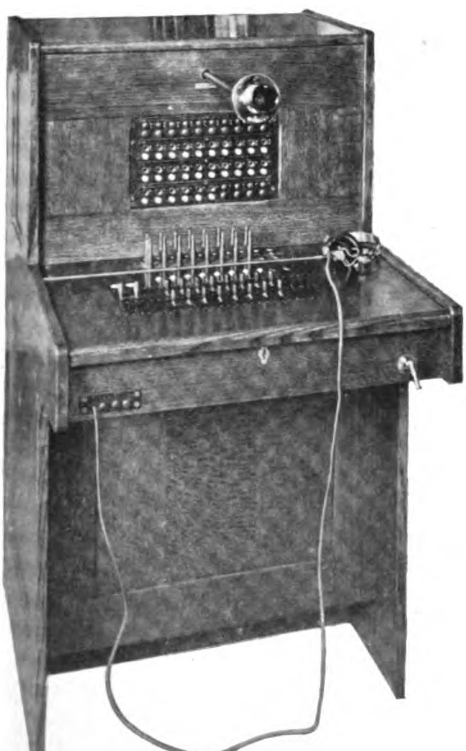


Fig. 43 — Typical Private Branch Exchange

Fig. 44-A — Dial on Subscriber's Set used with Automatic System

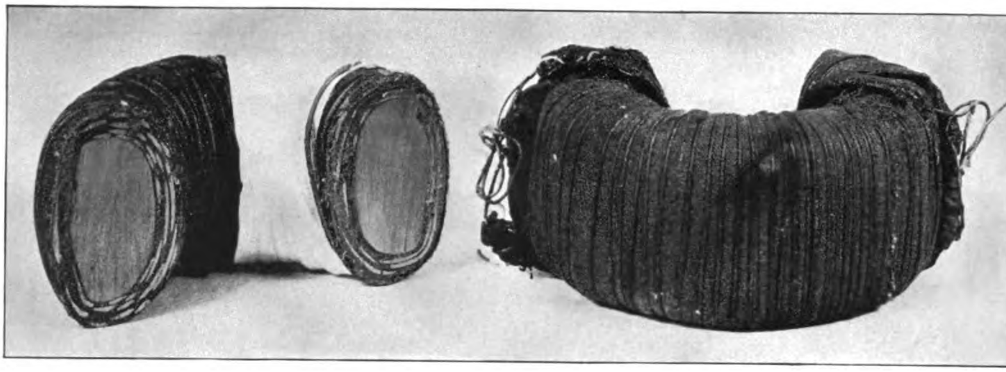


Fig. 51-B—Cable Loading Coil and Section. Wire Core Type

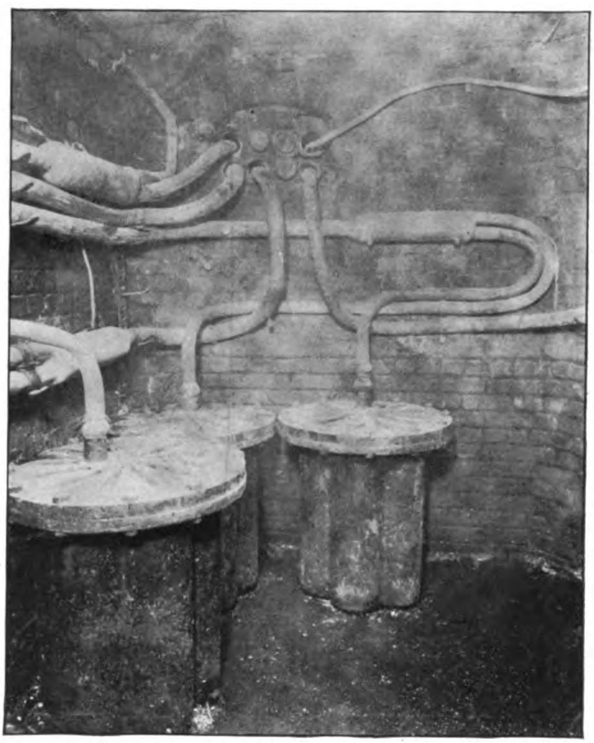


Fig. 52—Underground Manhole showing Pots containing Loading Coils, and connections from coils to cables

Fig. 48—Cross-section of 1200 Pair Cable

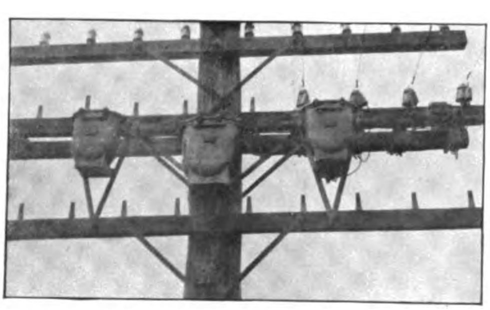


Fig. 53—Loading Coils in Iron Cases connected to an Open Wire Line

Fig. 55—Vacuum Tube Repeater Bulb and Socket

switchboard to a device known as a «spring-jack.» The insertion of one plug of a connecting cord into the spring-jack associated with the line of the calling subscriber and the plug at the other end of the same cord into the jack of the line of the called subscriber, placed these subscribers in connection so that they could talk with each other. The cords were provided with listening and ringing keys. The former enabled the operator to communicate with the calling subscriber to ascertain the line with which connection was desired. The latter permitted the operator to send alternating current over the called line for the purpose of ringing the called subscriber's bell. An electromagnetic disconnect annunciator in each cord circuit enabled either subscriber, by operating his magneto-generator, to signal to the operator that the conversation had ended.

as the «transfer» board. As the number of lines grew, it gave less satisfactory service and it was seen that, unless something better was developed, the switchboard would be a serious limitation on the growth of the business. The solution was found by multiplying the points of access to each subscriber's line so that a means of access (spring-jack) to each subscriber's line in the office appeared in the face of the switchboard within reach of every operator, thus obviating the necessity for trunking calls between operators in the same office. The switchboard in which this «multiple» principle was first used was known as the «series multiple» board. The invention of the multiple was made by L. B. Firman. A simplified diagram of the wiring of this board is shown in Fig. 39, which also illustrates the construction of the spring-jack. In this arrangement each subscriber's line was carried through the board with branching taps to the ring (outer contact) of the jack associated with the line at each operator's position. The other side of the line was carried through the board in series with the cut-off spring contact of each jack associated with the line. The object of the spring contact was to disconnect the line signal from the line while talking was going on.

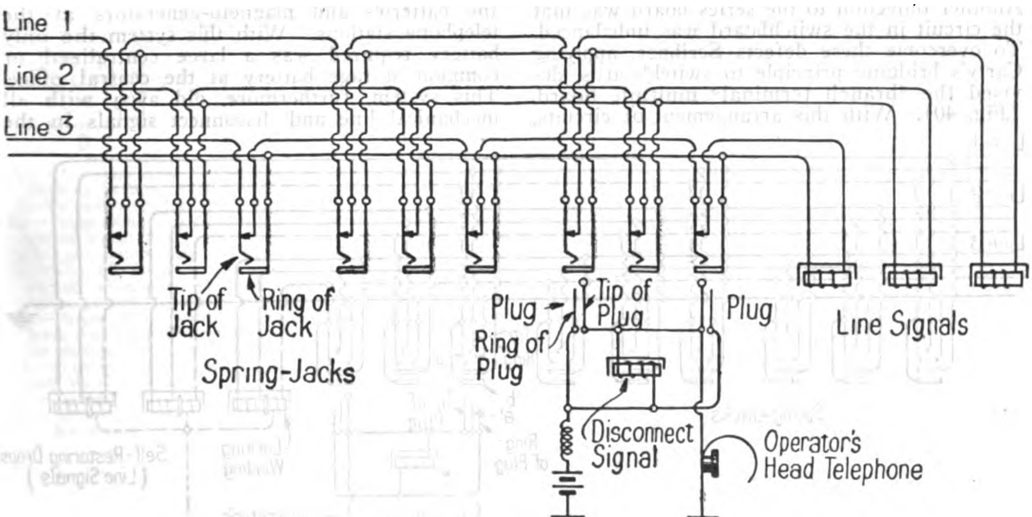


Fig. 39.—Simplified Circuit Diagram of Series Multiple Switchboard. (Operator's telephone shown connected for "busy test").

Switchboards of this general type were used until the number of lines terminating in a telephone central office had grown so large as to exceed the ability of one operator to complete all of the connections. This situation was met by placing two or more switchboards side by side, the operators completing the connections by reaching across, with their flexible cords, from one board to another. As the number of sections of switchboard placed side by side increased still further, the distance to which an operator could reach was exceeded. The next step was to join the sections of switchboard by metal strips or wires. An operator could then connect a calling subscriber with a certain strip and request another operator, more conveniently situated, to connect the called subscriber to the same strip. These strips constituted the first use of the so-called «trunk line» between switchboards. The practice led to much confusion, due to the operators calling out the desired numbers, and resulted in the development of means enabling the operators to communicate along the switchboard by telephoning one another. This type of switchboard was known

As every line appeared at several points, so as to be accessible to every operator, it became necessary to provide some means for indicating to the operator desiring to complete a connection, whether or not the called line was already in use. To accomplish this Charles E. Scribner, for many years chief engineer of the Western Electric Company — the manufacturing department of the Bell Telephone System — invented the click busy test. The circuits were so arranged by him that when one operator had inserted a plug in the jack of any line, an electrical potential was placed on the rings of all of the jacks of that line which were multipled before the operators. Any operator desiring to complete a connection with a line was required to touch the tip of the connecting plug against the ring of the jack with which connection was desired before completely inserting the plug into the jack. If the desired line was already in use, the potential on the ring of its jack would cause the operator to hear a «click» in her head telephone, thus indicating that the line was already in use through a connection established at some other part of the switchboard. These two very important principles — the multiple and the busy test — have persisted, in one form or another, in every large switchboard up to the present time. A serious objection to the series type of board was that dirt or dust, accidentally lodging in the spring jack contacts, would introduce high resistance into the line, or even cause the circuit to become open, thus interfering with or quite preventing conversation over the line. Another objection to the series board was that the circuit in the switchboard was unbalanced. To overcome these defects Scribner, applying Carty's bridging principle to switchboards, devised the «branch terminal» multiple board. (Fig. 40). With this arrangement of circuits, two wire system, the switchboard had to be adapted throughout to the new plan of working. This meant a wholesale displacement of existing grounded line switchboards by boards of the newer metallic circuit type.

For a long time after multiple switchboards came into use, batteries were required at each telephone station to furnish the current for actuating the transmitter, and magneto-generators, operated by turning a crank, were employed for signaling the central office whenever a connection was desired. The generator was also used for signalling «disconnect,» and was not wholly satisfactory for this purpose, as subscribers frequently neglected to give the disconnect signal, making it necessary for operators to «listen in» on connections and ask «Are you through?» The invention and development of the common battery system did away with the batteries and magneto-generators at the telephone stations. With this system the only battery required was a large centralized or common storage battery at the central office. This system, furthermore, did away with all mechanical line and disconnect signals in the

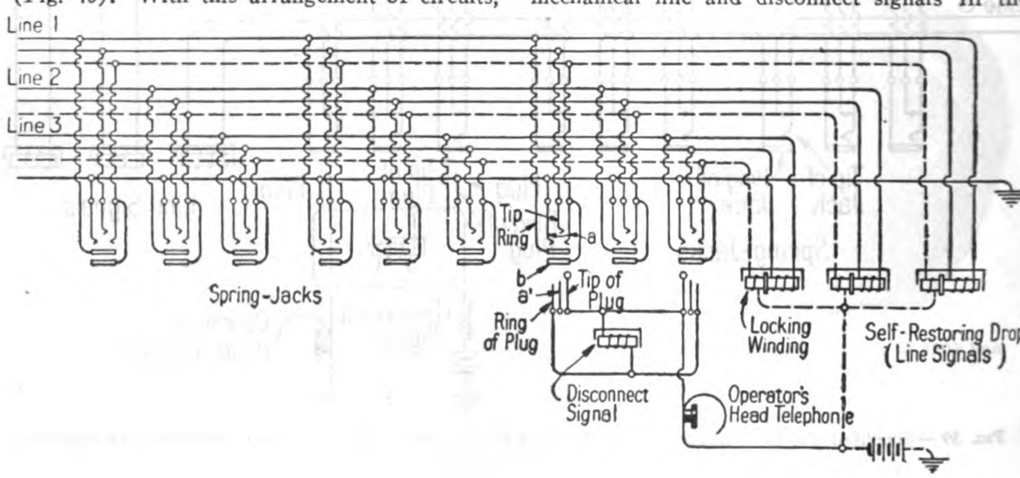


Fig. 40.—Simplified Circuit Diagram of Branch Terminal Multiple Board. (Operator's telephone shown connected for "busy test").

Description of operation: On insertion of plug, springs (*a*) are connected together by collar (*a'*) on plug, causing current to flow from battery, through locking winding of drop, to ground, restoring shutter of drop to original position, and also preventing operation of drop while line is in use. It also places test thimble (*b*) and all other test thimbles on same line at ground potential. Operator on touching such thimbles with tip of plug gets flow of current through her receiver, and is warned that line is in use, by click in her ear. When line is not in use, thimbles are at same potential as tips of plugs, and no click occurs.

bridged multiple taps were provided from each side of the line to springs in the jacks in the multiple before the operators, and the line signals were wound to a high impedance. By doing this, and adding a locking winding to prevent false operation, the need for disconnecting the line signals from the circuit when the line was in use was avoided. A feature added at this time was the «self-restoring» drop (line signal) which provided for the automatic restoring of the annunciator to its original position upon the insertion of a plug in the answering jack of the calling line. Before this time, the annunciators had to be restored by the operators by hand.

The metallic circuit principle (described below) was introduced in switchboards at an early date, for as soon as any of the lines in a telephone office were changed to the metallic, or switchboard by enabling tiny electric lamps, governed by relays, to be substituted for them. This was one of the most important improvements ever made in telephone switchboards. The subscriber, connected with a common battery board, calls the central office by merely removing his receiver from the hook, the motion of the latter causing a lamp associated with his line to light before the operator. Completion of the conversation is indicated to the operator by suitable lamp signals in the cord circuit, when the receiver is replaced upon its hook. The circuits of common battery switchboards are of two types,— the impedance coil type and the repeating coil type. Fig. 41 shows a typical circuit diagram of the latter type, which is the more generally employed. Fig. 42-A shows the front view of a modern common-battery switchboard. The operators sit on chairs in front of the switchboard. Fig. 42-B shows the detail of a single position. Where the telephone message is the unit of service charge, each subscriber's line is provided, at the central

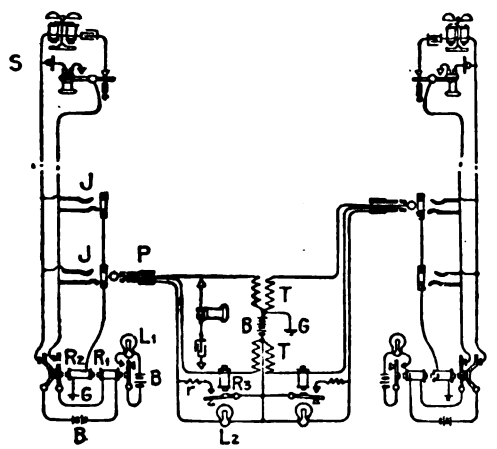


FIG. 41.— Simplified Circuit Diagram of Modern Common-Battery System. (Operator's telephone shown in position to be connected for "busy test").
R_1 — Line Relay. Operates on removing receiver at subscriber's station, S.
L_1 — Line Lamp. Lighted when R_1 is operated.
R_2 — Cut-off Relay. Operated by completion of sleeve circuit when plug, P, is inserted in jack, J. Operation opens circuit through R_1 and puts out L_1.
R_3 — Supervisory Relay. Operated when receiver is off hook and plug is inserted in jack. Operation puts out L_2 by shunting it by resistance, r.
L_2 — Supervisory Lamp. Lighted when plug is inserted and R_3 not operated.
B — Battery.
G — Ground.
T — Repeating Coil in operator's cord circuit.

office, with an accurate message registering device, by means of which each completed connection can be recorded.

Trunking Systems.— In large cities it is impracticable to concentrate all subscribers' lines at one central office on account of the distances involved, which affect both the resistance of the lines and their cost, and also on account of the fact that more than one switchboard would generally be required. Where several central offices are required in one city, connections from subscribers whose lines terminate at one office to subscribers whose lines terminate at another office must be completed with the aid of trunk lines connecting the offices. In the early days, an operator, initiating a trunked connection, by applying the busy test, selected an idle trunk line over which she called the operator at the distant office by ringing as though the trunk were a subscriber's line. When, in response to a signal operated by the ringing current, the operator at the distant office answered, the first-mentioned operator transmitted to her the number of the line with which connection was desired and this line was then connected by her to the trunk line.

Trunking was greatly improved by the advent of the reverse call-wire method. With this method the operator at the office where the call originates (known as the «A» operator), by depressing a push button key, of which she has one for each central office in the district, establishes connection with a call circuit permanently connected with the head telephone of the operator at the distant office (known as the «B» operator). The number of the desired line is then transmitted over the call circuit to the «B» operator, who, by visual inspection, selects an idle trunk line and transmits back its number to the «A» operator, who at once connects the calling party with that trunk line, the «B» operator meanwhile establishing connection between the other end of the same trunk line and the line of the called party. The call circuits are used for no other purpose than communication between operators.

Trunk circuits have been designed, and are in general use, which allow the «A» operator to supervise a connection completed in a distant office as readily as would be the case with a connection completed in her own office. The same is true of machine ringing circuits whereby the bell of the called subscriber at the distant office begins to ring automatically as soon as the trunk line plug is inserted in the jack of his line without the «B» operator being required to operate a ringing key.

Toll Boards.— The term «toll connection» is applied to connections between subscribers so far removed telephonically from each other that a special toll charge is made for the connection. On account of the fact that the toll lines between one place and another have to be grouped together for efficient operation and that each toll message has to be carefully timed and a ticket record made of the call, toll connections generally require special switchboard circuits and apparatus at the central office and the service of special operators. In the case of the smaller central offices the toll switchboard is sometimes combined with a portion of the local switchboard. In larger places, to enable adequate toll service to be given, separate large and complicated toll switchboards are ordinarily required. These toll switchboards are usually centralized at one point in the city and are connected by special trunk lines with the local switchboards in the several central offices of the city. In cities of the largest size more than one toll switchboard centre may be required.

Party Lines.— Serving more than one telephone user by means of a single line (party line) enables those having but little use for the telephone to obtain service on a basis which otherwise would be impracticable. The successful operation of the party line depends upon the Carty bridging bell principle already described. The extensive use of party lines to serve farmer's or rural stations, by destroying the isolation of the farmer, has produced a wonderful improvement in his economic and social life by placing him in constant touch with markets and sources of supply, and with the weather bureau, and has provided for his family a means of communication available not only for social purposes, but also ready at all times for summoning help in the event of sickness or danger. On party lines equipped with two stations, and on some equipped with four stations, means have been devised whereby the bell at a given party line station may be rung, the others meanwhile remaining silent.

Private Branch Exchanges.— Important adjuncts to the telephone central office are the private branch exchanges. These consist of switchboards, generally of small size, located in such places as hotels, apartment buildings or large business houses and having connected to them all the subscriber's lines in such establishments. Private branch exchanges are also connected with the nearest telephone central office by a sufficient number of trunk lines to handle the traffic arising from and flowing to them. Calls originating within the establishment where the private branch exchange is located, for parties within the same establishment, are completed by the private branch exchange operator without passing through the telephone central office. The introduction of the common battery system greatly facilitated the operation of private branch exchanges and enabled the necessary talking current to be supplied over trunk lines from the central office. Fig. 43 shows a typical private branch exchange of moderate size. Some of the largest private branch exchange switchboards are comparable in size to central office switchboards serving large communities.

Automatic Systems.— Throughout the development of the manually operated switchboard, the tendency was continually toward increasing the use of automatic labor-saving machinery. In the most modern forms of manually operated boards a complete analysis of all the operations involved shows that a large proportion of them are performed automatically. The term "automatic," or "machine switching," is, however, applied to systems in which the number of operators required at the central office is reduced to a relatively small number, the switching functions otherwise performed by operators being, to a greater or less extent, performed by electro-mechanical appliances. During recent years there has been extensive development of machine switching systems. The apparatus is highly complex and ingeniously devised.

In what is known as the full automatic system, the subscriber puts the automatic mechanism at the central office in motion and directs it so as to obtain the desired connection by suitably operating a movable numerical dial attached to the base of his substation set. Fig. 44 shows a typical set with the dial. The face of the dial is shown in Fig. 44-A.

Briefly the operation is as follows: Assume connection is desired with subscriber's line 753. The calling subscriber places his finger-tip in the hole of the dial, on his set, over figure 7 and turns the movable part of the dial in the direction of the hands of a clock, until his finger reaches the crescent-shaped stop. He then releases the dial which is automatically moved back, in the opposite direction, by a spring. This motion, by making and breaking a current on the line seven times, sets in operation in the central office an electro-mechanical device known as a selector, whose function it is to select some idle trunk line in the 700 group. These trunk lines terminate in other selectors of a similar type. By repeating the dialling operation, this time for figure 5, connection is established with the fifties in the 700 group. By dialling once again, this time for figure 3, the line of the calling subscriber is placed in connection with line 753. The selectors are made in a great variety of forms. In one form the terminals of the trunks and subscribers lines are arranged in panels, one above another, with selector rods moving vertically in front of these panels. In another form the terminals are arranged in layers around an arc, contact being established by a central arm capable of being raised to the proper level and then rotated.

In both forms suitable means are provided for automatically ringing the called subscriber's bell and for indicating to the calling party when the called line is already in use.

In the semi-automatic system the subscriber removes his telephone from the hook and transmits the desired number by telephone to the central office operator, as in the manual system. Thereafter, however, the operator makes use of automatic machinery at the central office to complete the connection, instead of performing the switching operations manually.

In modern telephone engineering the particular factors, surrounding each case where new central office equipment is to be recommended, are carefully studied in order to decide whether a manual, semi-automatic or full automatic system is, in view of all the circumstances, the best. The names of Keith, Lorimer, McQuarrie and Strowger are prominent among those who have contributed to automatic switchboard development.

Telephone Lines. Early Lines Similar to Telegraph Lines.— The first telephone line was a copy of the best telegraph line of the day. It was a single iron wire using the ground for a return circuit. In addition to electrical disturbances, coming from no one knew where, picked up by these early grounded lines, and frequently causing noises in the telephone so loud as to destroy conversation, it was discovered that iron wire was not as good a conductor for the telephone current as it was for the telegraph current. The talking distance, therefore, was limited by the imperfect carrying power of the conductor. It was realized that, if the telephone system was to grow, something better than iron wire would be required. Various metals and alloys were studied and it was found that copper best met the electrical requirements. But copper made into wire according to the then state of the art was too weak in mechanical strength. T. B. Doolittle conceived the idea that if a copper rod could be drawn cold through a series of dies, the resulting wire would acquire a degree of tensile strength much greater than that of the soft, annealed wire which was the only copper wire then known to the trade. He conducted a series of experiments which resulted in the production of commercial hard drawn copper wire having substantially all of the favorable electrical characteristics of soft copper wire, coupled with a tensile strength nearly double that of the soft wire, and fully equal to the strength of ordinary iron wire of the same size.

An experimental line, the first long distance telephone line in the world, was constructed in 1884 between New York and Boston, carrying two hard drawn copper wires 0.104 inches in diameter. The satisfactory conversations conducted over this line demonstrated the commercial feasibility of the new type of wire. In the following year, 1885, another line, built between New York and Philadelphia, was equipped with 24 hard drawn copper wires of various sizes. Careful experiments conducted on this line established the properties and qualities of the new product and the relative efficiencies of different sizes and variations.

Following this development, the use of hard drawn copper wire became the standard for long telephone lines, first in the Bell Telephone System, and later the world over, greatly extending the range of transmission. In 1892, New York was placed in telephonic communication with Chicago. The wire employed for

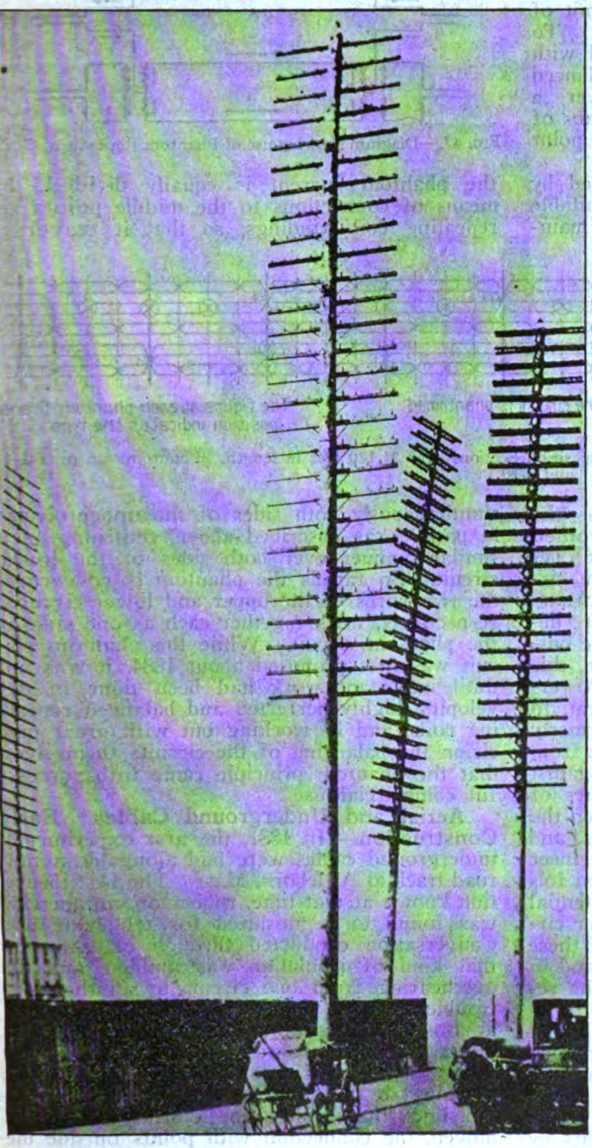


FIG. 45.— Highest Pole Line ever built, on West street, New York City. Poles were 90 feet long and some of them carried as many as 30 crossarms.

this circuit, which first realized the commercial 1,000-mile talk, was of hard drawn copper No. 8 B. W. G. in size (0.165 inches in diameter). The pair of wires required to connect Chicago with New York weighed about 870,000 pounds — a full load for a 22 car freight train.

Before the local service wires in cities had reached such numbers as to necessitate placing them underground they had been strung on poles and roof tops. This was objectionable on account of the corrosion of the iron wires by chimney gases, wires breaking when loaded with sleet, the cost of roof-repairing, the unsightliness of the construction and the lack of room for more wires. It was, however, the only possible way known at that period. The overhead method was soon outgrown. Some streets in the larger cities had become black with wires. Poles had risen to 50 feet in height, then 60, 70 and 80. Finally, the highest of all pole lines was built along West street, New York City, using 90 foot poles of Norway pine, and carrying 30 crossarms and 300 wires. (Fig. 45). This condition of wire crowding was overcome by the development of cables, later described.

Telephone Grounded Circuit. Difficulties.— When the ground was used for the return circuit, not only was the talking distance limited by the confusing effect of all sorts of disturbing currents from the atmosphere and from neighboring telegraph wires, but also, when a second telephone wire was strung alongside of the first, even though perfectly insulated from it, conversation carried on over one of these wires could be heard plainly on the other.

The Balanced Metallic Circuit. Open Wire Lines.— In 1883, it was discovered that the bad effects of these disturbing currents could be greatly lessened by severing the earth connection from the ends of each wire, and substituting a second wire for the return circuit through the earth. The new arrangement was known as the «metallic circuit.» For the reason that the «metallic circuit» principle involved rebuilding practically the entire plant, telephone engineers sought less costly methods of reducing the electrical disturbances.

Between 1885 and 1892, large numbers of so-called anti-induction devices were proposed and investigated. None of them proved sufficiently successful to warrant adoption. Those that killed induction killed transmission as well. A system using a common return wire for a number of telephone circuits was used to a considerable extent. It reduced the disturbances due to ground potentials but was not effective against induced currents. The reconstruction of the telephone plant on the metallic circuits basis was carried out largely between 1890 and 1900.

To aid further in rendering metallic circuits free from induction from power circuits and from crosstalk, the wires were transposed (i.e., interchanged in position on the crossarm) at periodic intervals of space.

The first transposition scheme was worked out in 1886.

Fig. 46 shows a typical transposition diagram for the 10 wires carried on one crossarm of a line. On this diagram the vertical lines represent poles 1,300 feet apart, that is, about every 10th pole. The interchange in position of the wires is indicated by the crossing of the horizontal lines which represent the wires. At the points indicated by small circles, special types of transpositions are placed to admit of phantom circuit working (described below). To ensure quiet circuits, the apparatus used with metallic circuits has to be carefully balanced when arranged for talking. Wherever a ground connection is used, as in some forms of signalling, it has to be placed at a neutral point in the telephone circuit.

Balance in the line circuits is attained by uniformity in the wire used and by suitable arrangements in its installation and maintenance. Any slight imperfection in the balance of the line conductors in phantomed circuits manifests itself by crosstalk between the phantom and its constituent circuits. While the metallic circuit, transposed according to the methods first devised by the Bell engineers, eliminated the outside disturbances that existed at the time, this was not the state of affairs for long. Powerful electric light and power circuits began to spring up and methods which had formerly been successful in protecting the telephone from disturbing currents were not effective against these new high powers. Years and years of work have been devoted to safeguarding the telephone circuit from these disturbances, and each new success which the telephone engineer has accomplished in this direction has been followed by a further advance in high potential and high current on the part of the power circuits. It has been said with truth that if these high power circuits had been discovered and in use before the telephone was invented, the results obtained from the first telephone lines would have been so utterly impracticable that it is hard to think of any one being rash enough to regard the telephone as having any commercial value.

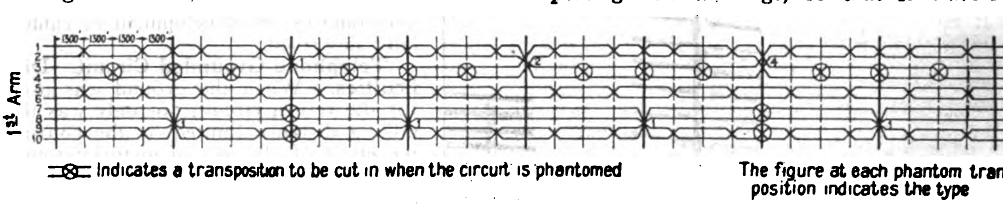


Fig. 46.— Typical Transposition Diagram for Transposition Sections over 21,120 feet in length. Phantoms on pins 1-4 and 7-10.

Phantom Circuits.— It is possible to make a third circuit out of two metallic circuits by connecting them together, with suitable apparatus, in a peculiar way. (Fig. 47). The third circuit is termed a "phantom" circuit. Conversations can go on over a phantom circuit without disturbing, or being disturbed by, simultaneous conversations over the two metallic circuits from which the phantom circuit is formed. The operation of the phantom circuit depends upon the principle that if two currents of exactly the same strength, and similar in all respects as to form, are transmitted simultaneously over the two wires of a circuit, they produce no sound in the telephones associated with that circuit. Fig. 47 shows how

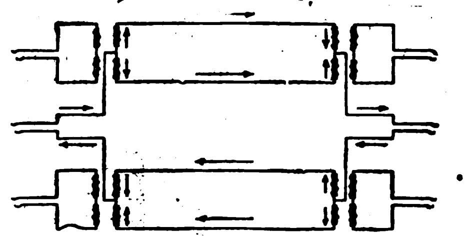


Fig. 47.—Diagram showing use of Phantom Repeating Coils.

the phantom current is equally divided, by means of connections to the middle points of repeating coil windings, so that it traverses simultaneously both sides of the upper circuit in parallel, as described above, returning in a similar manner over both sides of the lower circuit. So far as the phantom is concerned, the two wires of the upper and lower circuits, respectively, work together each as one side of the phantom circuit. While the phantom circuit was first proposed about 1884, it was not until important work had been done in developing highly perfected and balanced repeating coils, and in working out with great precision the balancing of the circuits themselves, that the phantom principle came into successful commercial use.

Aerial and Underground Cables. Early Construction.— In 1881, the first experimental underground cables were laid alongside a railroad track at Attleboro, Mass. The best insulation known at that time, rubber or guttapercha, was found to be unsuited for telephone use. Conversation conducted through cables using that kind of insulation was muffled, and the overhearing from one circuit to another was troublesome. In 1882 several cables were laid at Boston, Mass., the longest of which was about 1,500 feet. It was found that when these cables were used in connection with lines reaching to the suburbs, the voice became so indistinct that, unless the difficulty were removed, the connection with points outside the city would have been almost, if not quite, useless to those whose wires were underground. Type after type of cable was installed only to be withdrawn in a few years and replaced by something better.

The use of rubber insulated cable was followed by the development of a cable in which the individual wires were covered with cotton insulation and drawn into a pipe which was then filled with oil. This oil-filled cable carried the telephone business through half

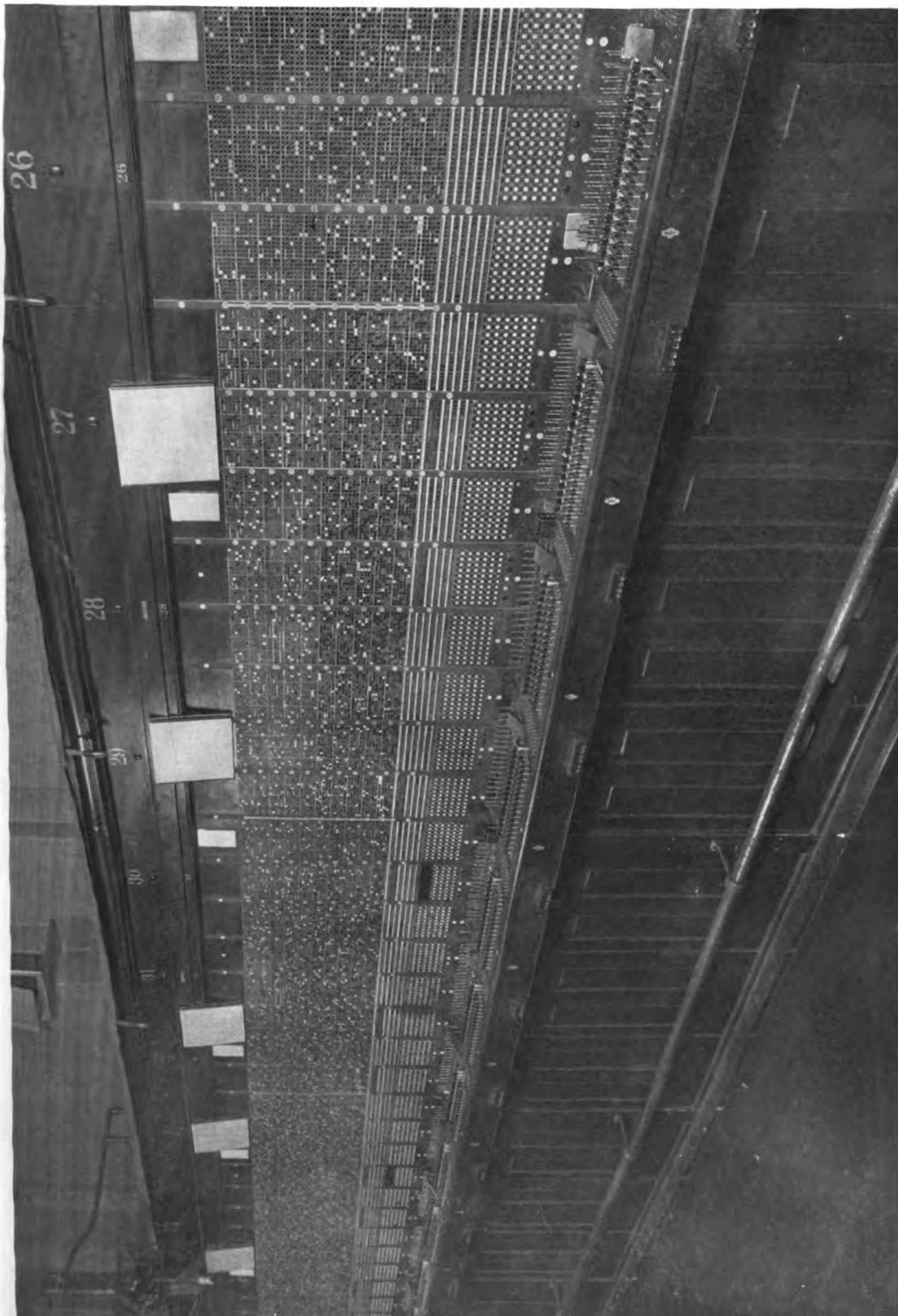


Fig. 42-A — Front View of a Modern Common-Battery "A" Switchboard

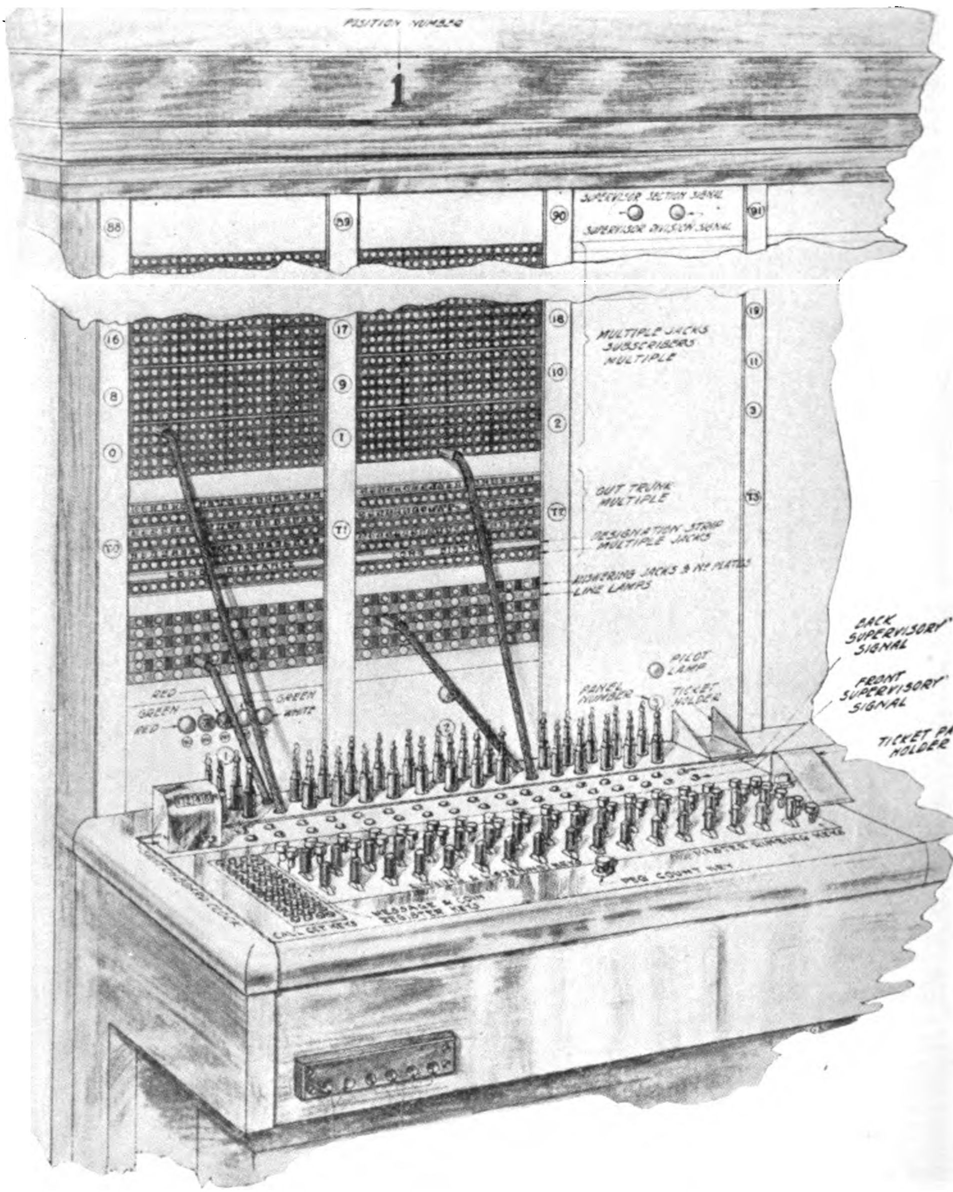


Fig. 42-B — Front View of Single Position of Modern Common-Battery "A" Switchboard

a dozen years but by no means was it the final type.

This was followed by the use of cotton covered wires having the cotton impregnated with a moisture-proof compound, the insulated wires being drawn into lead pipes, each section about 20 feet long. When the cable was laid the sections were connected by means of plumbers' joints. The next development resulted in the use of cable wires insulated with dry cotton, it having been found that cotton baked dry, so as to expel all moisture, was a good insulator if placed in a lead pipe and promptly sealed. This was an important development as cotton had formerly been considered a bad insulator. Moulding hot lead in a continuous sheath around the cable core of twisted wires was found to be an advantage as it meant a tight covering with fewer sleeves and splices and ultimately did away with the use of oil or moisture-proof compounds. By 1887 the introduction of twisted pair construction for conductors in cable began. This type of construction carried out the application of the transposed metallic circuit principle to cables. It obviated interference from overhearing (known in the art as "crosstalk") between circuits in the same cable. This improvement meant the abandonment of the entire existing cable plant and the introduction of the new type, without which the telephone system, as it is known today, would have been an impossibility.

Insulated Dry-Core Paper Cable.— More development work, extending over several years, constantly aiming to reduce the specific inductive capacity of the insulating material, led to experiments with paper twine. This proved too flimsy and methods were devised for putting paper on the wire flat, crumpling it around the wire instead of winding it tightly. This resulted in the production of the best type of insulating material known for telephone cables, namely, dry paper hermetically sealed in a continuous lead sheath. In 1890, "dry-core" cable, the first of the modern type, was laid in Philadelphia. The conductors, wound with loose paper, were really cushioned largely with air, the best insulator known. This was the best talking cable that had ever been made up to that time. The first dry-core paper cables contained 50 pairs of wires No. 18, B. & S. G. in size (0.0403 inches in diameter). By 1891, the use of wires No. 19, B. & S. G. in size (0.0359 inches in diameter) was settled upon. Subsequent progress in cables employing this size of wire has been largely in the direction of increasing the number of pairs of wires that can be placed in a full-sized sheath. This has been accomplished chiefly through improvements in the insulating paper and in the methods of applying the paper to the wires. The progress made is shown in the following table which gives, for cables of No. 19 gauge wires, about 2½ inches in outside diameter, the date when a cable of the given number of pairs was made available for commercial use:

DATE	Number of pairs of No. 19 gauge wires
1892	100 pairs of wires
1895	120 pairs of wires
1896	150 pairs of wires
1898	200 pairs of wires
1903	300 pairs of wires

Fine Wire Cable.— The extraordinary increase in the number of the telephone wires, and the difficulty in many places of obtaining additional space underground led to the development of the so-called "fine wire" type of cable employing wires No. 22, B. & S. G. in size (0.0253 inches in diameter). The progress made in this development is shown in the following table which gives, for cables of No. 22 gauge wires, about 2½ inches in outside diameter, the date when a cable of the given number of pairs was made available for commercial use.

DATE	Number of pairs of No. 22 gauge wires
1900	300 and 400 pairs of wires
1903	600 pairs of wires
1912	900 pairs of wires

During 1914, there was developed a type of underground cable carrying 1,200 pairs (2,400 wires) No. 24 B. & S. G. in size (0.0201) inches in diameter). Fig. 48 shows a cross-section (reduced in size) of this cable. The improvement which it represents may be understood when it is known that to carry the same number of open wires on poles would require 8 huge pole lines of the size shown in Fig. 45. The economies accomplished by these improvements are not limited to the cables themselves, but extend to the underground duct systems whose capacity is multiplied enormously by the increase in the number of wires which each cable may carry.

It was early found that lead alone did not possess the requisite corrosion-resisting and strength properties for underground cable sheaths. Aerial cables, furthermore, are subject to peculiar conditions causing vibration in the cable, and a tendency to crystallization of the sheath if pure lead is employed. For a long period, cable sheaths having the proper qualities were made of lead alloyed with about 3 per cent of tin. Considerable increases in the cost of tin led to experimental investigations of a wide range of other alloys. This resulted in finding, in 1912, a cheaper and at least equally efficient alloy in which the lead was alloyed with a very small amount of antimony.

Early Interurban Cables.— In the earliest interurban cables every effort of the engineers was bent toward improving transmission efficiency by using wires of large size so arranged in cabling as to secure a soft core giving the lowest practicable mutual electrostatic capacity between the wires of a pair. Wires as large as 0.095 inches in diameter were used and cables of this character as long as 25 miles were placed. In European practice, the use of wires even larger than this continued for many years. In the United States, the development was in the direction of using smaller wires provided with means for improving their transmission efficiency so that it not only equaled, but considerably exceeded that obtainable with the larger and more expensive wires. By 1902, the art had so advanced, by the use of Pupin loading coils (described below) and other improvements, that a loaded cable for suburban toll service was successfully installed between New York and Newark. By 1905, a loaded cable 20 miles long had been extended from New York in the direction of Philadelphia, and by 1906, a cable 90 miles long was successfully operated between those two cities, but in the then state of the art, that cable could not be used beyond Philadelphia or New York.

Boston-Washington Underground Cable. — During the year 1913 such advances were made in the art of loading and balancing underground circuits, and such improvements in the use of repeaters (described below) that it became possible to talk satisfactorily by underground wires from Boston to Washington, a distance of about 450 miles, employing a cable (Fig. 49) so designed that the phantom principle could be employed in it. At the present time, there are underground cables along this whole route, furnishing service of the highest reliability between many important cities, the number of cables varying from two to four, depending on the density of the telephone traffic. Loading is used on all the circuits in these cables, and repeaters are applied to a large proportion of the circuits over 60 miles in length. The Boston-Washington telephone cable is several times longer than any other in the world. These developments tended to increase greatly the long-distance traffic and to accomplish enormous savings in the amounts of copper which otherwise would have been required to establish communication between remote points.

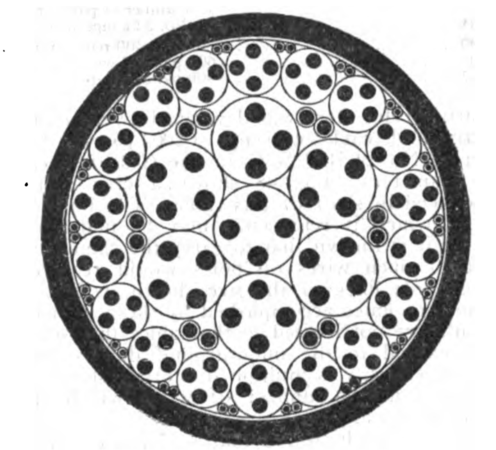


FIG. 49.— Diagrammatic Cross-section of Boston-Washington Underground Cable. (Outside diameter, 2 9-16 inches).

Telephone Transmission Theory.—In telephony, as already described, mechanical vibrations of the transmitter diaphragm set up electrical oscillations. These are transmitted over the circuit and set up corresponding mechanical vibrations of the receiver diaphragm. The following section deals with the electrical characteristics of the telephone circuit and the transmission of telephone currents over it.

To develop the principles of telephone transmission, it is necessary to know the character of the speech waves. For ordinary practical working, satisfactory results are obtained on the basis that speech waves, largely the overtones of the voice, consist of a varying mixture of single frequency tones ranging from about 400 cycles per second (in musical sound, equivalent to G above middle C) to about 2,000 cycles per second (approximately the octave above high C), and that each frequency persists in a constant state for a sufficient length of time to follow the same electrical laws as though it persisted for a long time. This basis is by no means exact, since frequencies outside the above range are of some importance in speech, and speech is so irregular and discontinuous in character that the transient oscillations, which are produced by the rapidly changing speech waves, are in many cases of considerable importance.

A telephone line possesses four «linear constants» on which depend the character of transmission over it. These, with the symbols employed to represent them in the formulæ which follow, are:

Resistance in series with the line. Symbol R.

Inductance in series with the line: Symbol L.

Capacitance shunted across the line: Symbol C.

Conductance shunted across the line: Symbol G.

The differential equation determining the transmission of current over the line with these constants is as follows, «i» standing for the current, «x» for the distance measured along the line and «t» for the time:

$$\frac{d^2i}{dx^2} = \left(LC\frac{d^2}{dt^2} + \left[RC + LG\right]\frac{d}{dt} + RG\right)i$$

For a current of a given frequency $f = \frac{p}{2\pi}$ cycles per second, there may be deduced, from the above equation, the following expression for the current at any point in a long line, when the current at the sending end is $I_0 \sin pt$.

$$i = I_0 e^{-\alpha x} \sin(pt - \beta x)$$

In this expression are used two constants, α and β, known respectively as the «attenuation constant,» and the «wave length constant.» The expressions for these constants are as follows:

$$\alpha = \sqrt{\tfrac{1}{2}\sqrt{(L^2p^2 + R^2)(C^2p^2 + G^2)} + \tfrac{1}{2}(RG - p^2LC)}$$

$$\beta = \sqrt{\tfrac{1}{2}\sqrt{(L^2p^2 + R^2)(C^2p^2 + G^2)} - \tfrac{1}{2}(RG - p^2LC)}$$

The first of these constants determines the rate at which the current diminishes in amplitude as it passes along the line. The second determines the velocity at which electrical phase is propagated along the line. Another important constant of a line is its so-called «characteristic impedance,» which is the ratio of the voltage applied to a line to the current entering the line. In terms of the above noted constants, the expression for it is:

$$Z = \sqrt{\frac{R + jLp}{G + jCp}}$$

Where a line is not electrically long, and is terminated with an impedance differing from the characteristic impedance of the line, then the formula as given for the current at any point along the line must be modified to take account of the «reflection effects» which take place due to this difference in impedance. Such reflection effects may be reduced, in practical cases, by placing a transformer of proper ratio between two lines, or between a line and terminal apparatus of different impedance. An analysis of the above formulæ will show that not only is the energy in the speech waves attenuated as they pass over the line, but that different frequencies of speech are attenuated at different rates, the higher frequencies generally undergoing the higher attenuations. Therefore, not only is the volume of energy received less than that transmitted, but the character, or «quality,» of the speech wave is distorted. In addition to this distortion of speech waves, there is further distortion, due to transient effects, already referred to.

Loaded Lines.—«Loading» is a practical method for increasing the efficiency of long telephone circuits by increasing the inductance of the circuit. The mathematical possibility of doing this had long been realized but no one was able to point out any practical method of increasing the distributed inductance of a telephone circuit without bringing difficulties of one kind or another which were fatal. Vaschy, Heaviside and others either suggested or unsuccessfully tested the insertion of self-induction in coils on actual lines as a means of increasing their transmission efficiency. No practical results followed from their work and no actual progress was made in the matter of using lumped inductance to improve the transmission efficiency of telephone circuits until the year 1900, when the patents of Prof. Michael I. Pupin, dealing with the reducing of attenuation of electrical waves, were issued. Professor Pupin and Dr. George A. Campbell of the Bell Telephone Research Staff, who had also worked on this problem, have published several papers dealing with it. These authors discuss fully the mathematical theory of loading and establish the fact that inductance in coils suitably spaced along a telephone circuit will produce the same effects as uniformly distributed inductance. They also show how to locate these inductance coils suitably. The matter of properly spacing the inductance coils is of vital importance and must be kept in mind because the spacing of the coils is the key to the use of lumped inductance and it was from the failure to establish this fact and give due weight to it that the earlier workers failed.

Fig. 50 shows, in a diagrammatic form, the

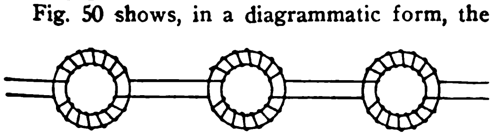


FIG. 50.— Diagram of Loading Coil Windings and method of connecting into line.

manner in which the lumped inductance coils («loading» coils) are connected into the telephone circuit. Figs. 51-A and 51-B show a coil of the type applied to cable circuits. Large numbers of such coils are contained in a single case as shown in Fig. 52. Fig. 53 shows a typical form of loading coil of the kind applied to open wire lines.

The function of these coils is to reduce attenuation losses in the line. They bring in no supply of new energy, but make the line a better conductor for telephone currents. On open wire lines they are placed at intervals of about eight miles. On cable circuits they are placed

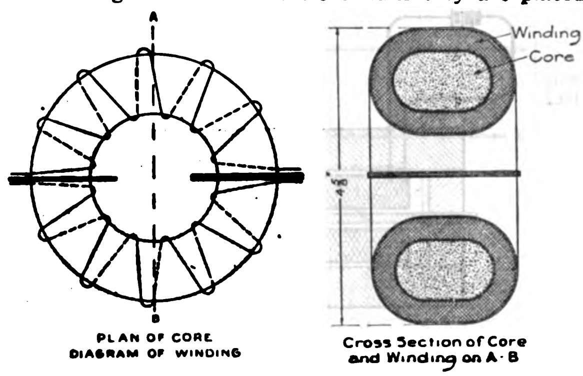


FIG. 51-A.— Diagrams of Cable Loading Coil.

at intervals of from one to two miles depending upon the size of the cable conductor to be loaded and the character of the loading. The use of these coils approximately doubles the range of transmission practicable with open wires of a given size and increases the range of cable transmission three to four-fold. In other words, by means of loading, it became possible to talk over cable circuits three to four times as far as formerly, with equally good transmission results.

The fundamental principles of loading, as disclosed in the patents of Pupin, were in mathematical form. The development work required to embody the theory of loading in practical loading coils has been a task constituting the work of years of a large group of highly trained scientific men on the technical staff of the Bell system. The application of loading has comparatively recently been extended to phantom circuits so that it is now possible to load not only the physical or side circuits composing a phantom circuit, but also the phantom circuit itself. Phantom loading is applicable to suitably constructed cables (called duplex or «quadded» cables) as well as to open wire lines.

Telephone Repeaters.— A highly important method of improving the transmission efficiency of telephone circuits is the insertion into them of devices known as «telephone repeaters,» which increase the amplitudes, or strength, of the telephone currents that pass through them, without changing the effective form of the waves. The energy added by the repeaters is drawn from a battery associated with the repeater itself.

The telephone repeater may be considered as consisting of two parts: (a) the repeater «element,» that is, the amplifying device itself; and (b) the circuits and associated apparatus for connecting the repeater element, or elements, into the line.

The first form of repeater element to come into commercial use was the so-called «mechanical» type consisting, in principle, of a telephone receiver acting directly into a telephone transmitter. A simplified diagram of this repeater is shown in Fig. 54. Currents received from the line flow through the winding of a receiver magnet acting upon a diaphragm carrying one electrode of a transmitter button, thus causing to be put out currents of approximately the same form as the incoming waves, but of greater amplitude.

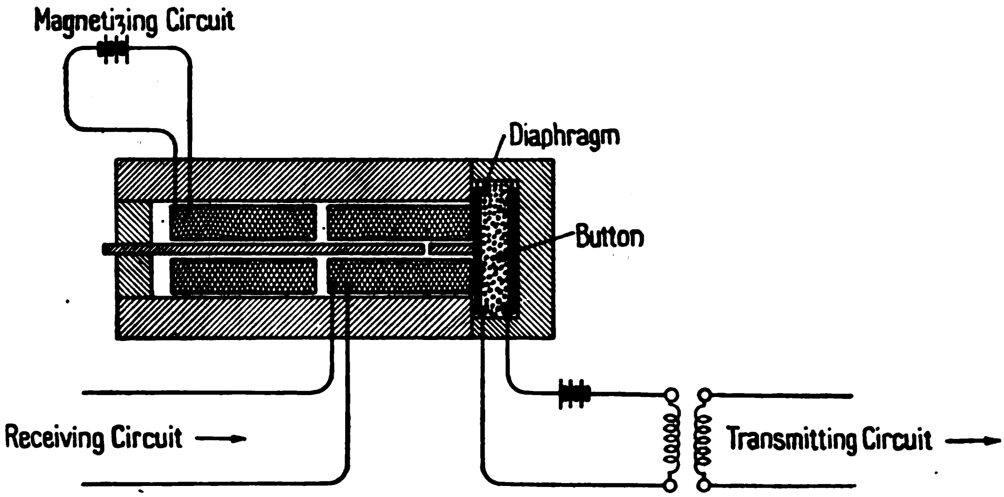


Fig. 54.—Simplified Diagram of Mechanical Type Repeater Element.

The preferred form of telephone repeater element is now the «vacuum tube» type. This was developed by the Bell engineers from a device known as the «audion,» invented by DeForest for other uses. The structure of this type of element is shown in Figs. 55 and 56. It consists of a highly evacuated glass bulb in which are placed three parts, known as filament, grid and plate. Referring to Fig. 56, the filament is composed of materials which, when heated by current from battery *A*, give off electrons actively. Under the action of battery *B*, these electrons pass from the filament to the flat electrode, known as the «plate,» thus constituting an electric current. The grid, so termed from its grid-like structure, is maintained generally at a potential negative to the filament by battery *C*. The incoming voltage sets up variations in potential difference between the grid and filament, and the electrical field thus produced causes corresponding changes in the current between the filament and plate, thus setting up amplified waves of the same form in the transmitting circuit.

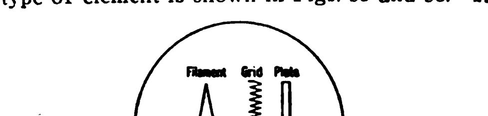


Fig. 56.—Diagram of Vacuum Tube Repeater. (The grid and plate at the left hand side of the filament are omitted for the sake of clearness).

The circuits for connecting the repeater elements into the line to give transmission in both directions are of various types, the two commonest forms being shown in Figs. 57 and 58. The first includes a single repeater element which amplifies the energy for transmission in either direction. The second includes a separate repeater element for transmission in each of the two directions. An important feature in these circuits is the balanced condition which is essential.

The circuit diagrams show certain auxiliary apparatus such as the «balancing network,» a combination of coils and condensers to simulate the actual line for balancing purposes; the «potentiometer,» a device for adjusting potentials; and the «filter,» which serves to blot out certain undesirable current elements.

Referring to Fig. 57, it will be noted that, if the lines in both directions are similar, and have, therefore, similar impedance, the amplified currents, leaving the repeater element, will cause no current to be set up in the receiving circuit of the repeater element. If, however, the circuits are sufficiently dissimilar, the balance is imperfect, and current put out by the repeater element will cause currents in the receiving circuit of the element which will again be amplified, thus setting up a circulating path in which current will flow. If the unbalance is sufficiently great, a steady state of oscillation may be set up that will prevent the use of the circuit. On the other hand, if the unbalance is not so great as to produce steady oscillations there may still be considerable distortion caused by it.

In the case of the second circuit (Fig. 58), similar conditions hold, except that in this case each line is balanced against an artificial line as indicated. If the unbalances at these points are not kept small, sustained oscillations may be set up as in the case of the other circuit, but in this case the circulating currents must flow through the two unbalances in series. If either balance is very good, the other unbalance may be large without unfavorable results.

The balances noted above must be obtained for all of the frequencies important in telephone transmission. The impedance of a circuit, measured at any point, is affected by every part of the circuit, the amount of the effect caused by any part being dependent on the amount of attenuation between the part being considered and the point at which the impedance is being measured. It is, therefore, evident that these balance conditions are affected by every part of a circuit on which the repeaters are used, so that every part of a circuit containing repeaters must be carefully designed with respect to this characteristic. For high grade repeater elements, the improvement obtainable under any particular circumstances is dependent, almost wholly, on line conditions.

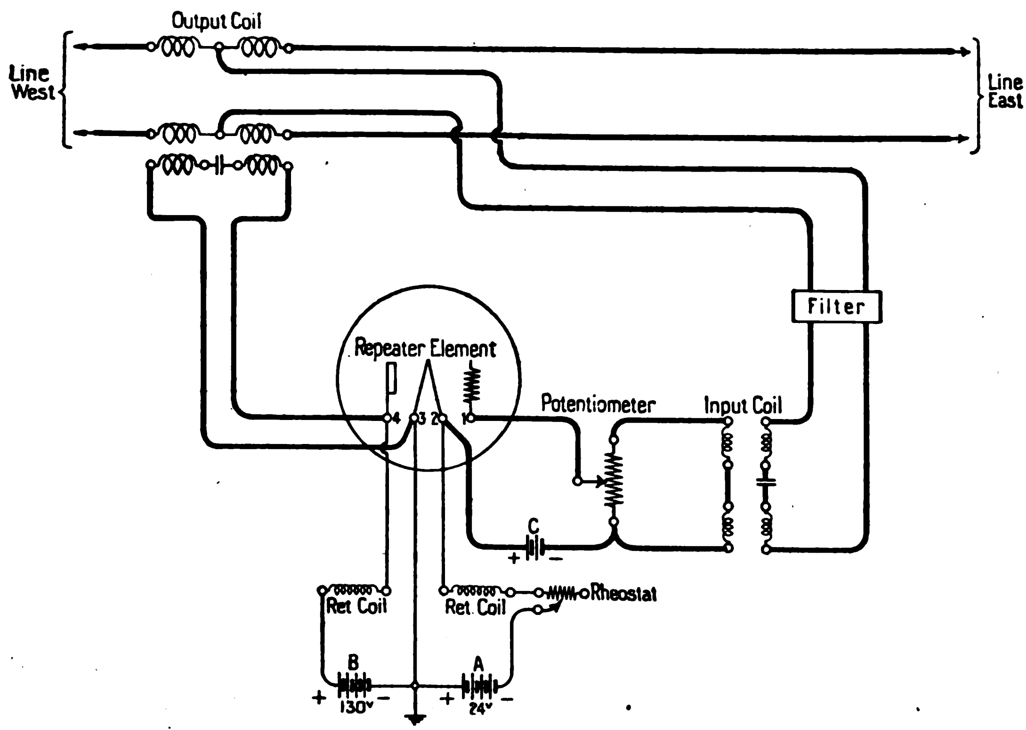


Fig. 57.— Simplified Diagram of Circuit with Single Repeater Element.

Transcontinental Circuits.— The best known circuits on which repeaters are used are those which place the cities along the Atlantic seaboard in telephonic communication with the cities along the Pacific Coast. Without loading and repeaters it would be impossible to talk 1,000 miles with the same grade of transmission that is actually obtained over these circuits 3,000 miles in length.

Further Advances.— By the joint operation of loading and repeaters, coupled with other advances recently made, it is now possible to carry on satisfactory talks over wires in cables more than 1,000 miles in length, where commercial conditions will justify them, employing practically no more copper in each circuit than was used 35 years ago in cables which caused serious interference with transmission when employed in lengths of only a fraction of a mile.

Interference from Other Electrical Systems.— Telephone lines, except those in underground cable, are generally subject to disturbances from lightning, and to the possibility of accidental contact with ordinary electric light and power distribution wires. When these conditions exist, protectors are successfully used on the telephone lines to minimize the hazard to persons and property. It is not practicable to use protectors which will handle the large amounts of energy that would be imposed on telephone lines by high voltage transmission circuits coming in contact with them. Protection from such circuits is obtained by keeping them separated from the telephone circuits wherever practicable and, where adequate separation is not practicable, by building the lines of high strength so as to prevent contact.

Multiplex Telephony.— The only type of multiplex telephone apparatus that has been developed into form suitable for commercial use is known as the carrier current multiplex system with which it has been found commercially practicable to transmit five telephone conversations simultaneously over the same pair of wires. This requires sending over the line five different currents at the same time and providing means, at the end of the line, whereby these currents may be completely separated from each other so that each current, coming from one particular telephone at one end, may go to a particular telephone at the other end, although on the line the five currents have all been mixed together. This is done by combining each ordinary telephone current with a current of definite higher frequency, termed a «carrier current.» The frequency of each of the carrier currents is different from that of the other carrier currents used on the same pair of wires and is adjusted to the separating devices at the distant end of the line. The arrangement is applicable on lines of such length that the installation of the necessary apparatus gives a saving in cost compared with erecting new circuits.

Telephone Systems.—The Bell System consists of nearly 11,000,000 telephone stations scattered all over the United States. Each station is enabled to connect with the nearest central office, of which there are upwards of 5,700, by a pair of wires called the subscriber's line, or «exchange circuit.» Due to party lines and private branch exchanges, about 3,700,000 exchange circuits serve to connect all the stations with the central offices. In places of moderate size there is usually one switchboard, to which all of the subscribers' lines are brought, local connections being completed within that switchboard. Large cities have a number of switchboards, connected together by trunk lines, all of the more important central offices having trunk lines connecting each switchboard with every other important switchboard in the city. To reach the smaller central offices, in outlying sections of a large city, from central offices, particularly those in a distant portion of the city, it is sometimes necessary to make use of two or more trunk lines, connected together by intermediate operators for the purpose of completing such a call. In the business portions of the largest cities where the telephonic density is at the highest, more than one switchboard is sometimes placed in a central office building.

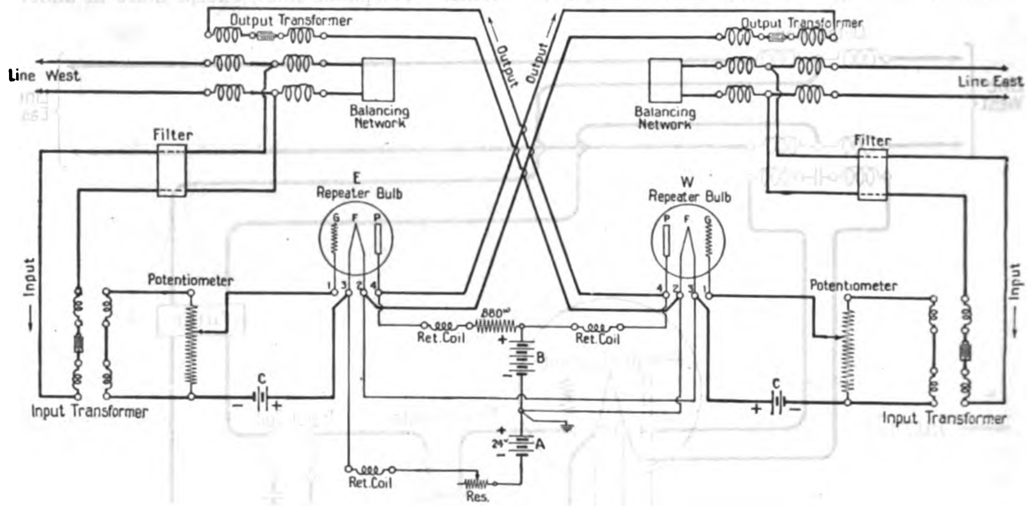


FIG. 58.— Simplified Diagram of Circuit with Two Repeater Elements, each line balanced against an artificial line.

In New York City, the largest exchange system in the world, there are upwards of 800,000 telephone stations, connected by more than 400,000 lines with 87 central offices which are inter-connected by more than 50,000 trunk lines, handling local calls only.

Connections between exchanges in different cities are completed over toll and long distance lines. More than 3,000,000 miles of wire are in use for this purpose. Special trunk lines are usually employed for connecting central offices with toll and long distance switchboards.

STATISTICS — NUMBER OF TELEPHONE STATIONS IN UNITED STATES.

YEAR (1 Jan.)	Bell system			Independent	Total Bell and independent	Population	Stations per 100 population
	Owned stations	Connected stations	Total				
1880	30,872	....	30,872	....	30,872	49,673,000	0 06
1885	147,715	....	147,715	....	147,715	56,069,000	0.26
1890	211,503	....	211,503	....	211,503	62,464,000	0.34
1895	270,381	....	270,381	15,000	285,381	68,988,000	0.41
1900	666,733	10,000	676,733	328,000	1,004,733	75,511,000	1.33
1905	1,838,034	167,213	2,005,247	1,348,000	3,353,247	83,411,000	4.02
1910	3,522,079	1,620,613	5,142,692	1,853,000	6,995,692	91,500,000	7.65
1915	5,584,853	3,064,140	8,648,993	1,397,425	10,046,418	99,590,000	10.09
1919	7,201,757	3,790,568	10,992,325	1,085,312	12,077,637	106,062,000	11.39

About 3,400 trunk lines are used for this purpose in New York City alone.

There are, in the Bell System, about 200,000 employees. It is impossible to describe, in an article of limited length, many matters of importance in the operation of telephone systems, such as traffic and commercial features.

TELEPHONE WIRE MILEAGE OF THE WORLD
(1 Jan. 1914)*

COUNTRY	Miles of wire	Per cent of total
United States	22,137,000	59.3
Canada	1,149,000	3.1
Europe	11,800,000	31.6
All other countries	2,251,000	6.0
Total	37,337,000	100.0

NUMBER OF TELEPHONE STATIONS IN THE WORLD
(1 Jan. 1914)*

COUNTRY	Number of stations	Per cent of total world	Stations per 100 population	Population per square mile
United States	9,542,000	64.09	9.7	33
Canada	499,800	3.36	6.5	2
Central America	7,900	.05	0.1	27
Mexico	41,900	.28	0.3	20
Other North American places	2,300	.02	0.7	0.4
Cuba	16,100	.11	0.7	49
Porto Rico	4,400	.03	0.4	342
Other West Indies places	6,600	.04	0.1	114
South America	166,300	1.12	0.3	8
Europe	4,012,700	26.95	0.8	121
Asia	306,100	2.05	0.04	53
Africa	65,100	.44	0.05	12
Oceania	217,400	1.46	0.4	13
Total	14,888,600	100.0	0.9	33

* No complete European statistics of a later date than 1914 are available.

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BANCROFT GHERARDI,
Chief Engineer, American Telephone and Telegraph Company.

FREDERICK L. RHODES,
Outside Plant Development Engineer, American Telephone and Telegraph Company.

TELEPHONE SYSTEMS, Cost of Installing and Maintaining. See TELEPHONE SYSTEMS, INDEPENDENT.

TELEPHONE SYSTEMS, Independent. Under this designation are placed all those telephones not owned by Bell system companies, such as certain telephones used for military purposes, some of the telephones in those cities where there are two or more exchanges existing and operating side by side, such interior telephones as are used solely for inter-communication in buildings, hotels, factories, etc., and some of the farm or rural telephones.

The original Bell patents expired in 1893 and for 17 years prior thereto the patents granted to the first inventor of the telephone were upheld in the United States and all telephones in commercial use were supplied under license by the predecessors of the American Telephone and Telegraph Company. Upon the expiration of the original Bell patents, numerous manufacturers began to supply telephone instruments and considerable numbers of these came into use especially in the rural districts.

*Transactions of American Institute of Electrical Engineers.

For many years the independent development of the telephone business has been in progress largely in the rural districts where local co-operative and rural independent companies are established. A large proportion of these now have connection contracts with the Bell system. These lines are found in every part of the country, uniting homes, factories and camps by means of party lines, which allow conversation between the different stations of the line as well as from any station to a central exchange.

Up to the present time the independent telephone movement has placed more than 800,000 American farmers, timbermen and miners in touch with their markets, their own communities and towns and cities near them. The movement has been especially active in the Middle and Western States. These telephones are used not only for general purposes of communication, and in numerous ways for securing information regarding market quotations, but also in gaining information of financial value and advantage. The independent telephone business, however, is not limited to the country or isolated districts but has established itself in a number of cases in towns and cities.

In many cases, where two systems have come into existence, side by side, arrangements have been made to consolidate the systems by one interest disposing of its plant to the other. Such consolidations have very generally met with the approval of regulatory bodies and in this way many telephone users have had their range of communication greatly extended.

The growth of the independent systems increased over 250 per cent in the decade beginning about 1902 and ending in 1912. In the year first named there were reported in operation 9,092 independent systems and lines with 1,512,527 miles of wire. The number of telephones operated on these systems was 1,053,866 and the number of messages or conversations per annum was estimated at 1,996,024,493. In the year 1912 the independent systems had increased to 32,157 with 5,115,140 miles of wire and operating 3,642,565 telephone instruments. The estimated number of messages or conversations over these independent systems in the latter year was 4,602,431,409. Of the total number of stations in the Bell system, in 1918 (10,992,325), 3,790,568 were owned by local cooperative and rural independent companies or associations having sublicense or connection contracts with the Bell system. There are in the United States 9,338 independent companies whose telephone systems connect with the Bell system, and about 1,600 independent companies whose telephone systems do not connect with the Bell system. There are also a large number of rural lines and systems which connect with the telephone systems of these companies, over 26,000 of which are connected with the Bell system. There are about 1,000,000 stations owned by independent companies not connected with the Bell system.

The exigencies of war service emphasized the great adaptability of the telephone to many situations and there was an increased call for telephone systems for reporting enemy operations, directing the movements of troops, munitions and supplies, controlling artillery fire and in numerous other ways increasing the effectiveness of the armed forces.

The scientific investigation of electromagnetic waves has resulted in a clear understanding of the generation, propagation and detection of these waves and in the development of wireless telephony. The requirements of successful radio-telephony began with a generator of undamped waves of very high frequency, so that the wave trains when received were above the range of audibility. Wireless telephony owes much to the work of the engineers of the American Telephone and Telegraph Company, who, in the latter part of 1915, succeeded in telephoning by wireless from Washington, D. C., to Paris, and from Washington to Hawaii, the latter a distance of 4,900 miles. The great expense of installations for long-distance work may limit competitive systems, but it is safe to look for the widespread employment of independent short-distance wireless telephone sets.

Armies in the field employ portable wireless sets for insuring communication between scattered commands. Some sets for use in rugged country are arranged to be carried on muleback and are known as pack sets; but the most common wireless sets are those mounted on two wagons, one for the generating equipment and the other for the wireless apparatus proper. The European War gave especial impetus to wireless telephony, especially as applied to air craft. In designing radio apparatus for airships and aeroplanes due consideration must be given to the extremely limited space available on such craft and the limited weight that can be carried. On board airships of the Zeppelin or the flexible types it is possible to employ more powerful apparatus, hence a greater range can be covered.

A typical airship installation consists of a transformer, quenched spark gap, capacity and inductance, aerial wire lowered down from a winch, ammeter, rapid-change switch for different wave-lengths and an alternating current generator driven off one of the engines of the airship. Such a set weighs about 55 pounds without the alternator and has a range between 60 and 120 miles. The aerial wire is over 600 feet long when fully paid out.

TELEPHONE TRANSMITTERS. See TELEPHONE.

TELEPHONES, Electrical. See TELEPHONE.

TELEPHONES, Farm. See TELEPHONE SYSTEMS, INDEPENDENT.

TELEPHONY, Wireless. Prior to the transmission of speech without wires by means of ether waves developed electrically several more or less successful wireless methods of transmitting speech were utilized experimentally; For instance, a device termed the photophone

FIG. 1.—Bell's Photophone

was employed by Bell, the inventor of the telephone, in which light rays were utilized. In this device, Fig. 1, a beam of light is concentrated by means of a lens *l* upon a small concave mirror carried on the exact centre of a diaphragm attached to a mouthpiece *P*. The rays reflected from the mirror are directed upon a receiving apparatus by a double convex mirror l^1 suitably positioned. In the receiving apparatus a small selenium cell is placed in the focus of a parabolic reflector l^2. This cell is made part of an electric circuit consisting of a telephone receiver t and an ordinary dry cell b. Selenium possesses the property of varying its electrical resistance with the variations of light to which it is exposed. Hence when speech is uttered at the mouthpiece the diaphragm vibrates in consonance with the sound waves of the voice. These vibrations cause variations in the light rays reflected from the small mirror, which variations are reproduced at the selenium cell. This in turn causes variations in the resistance and current of the telephone circuit and the speech spoken at the mouthpiece is reproduced in the telephone receiver.

The rate of air vibrations or oscillations due to speech ranges from about 20 to 20,000 per second. As the length of an electric wave or oscillation is equal to the speed of electricity, 186,000 miles per second, divided by the number of oscillations per second, it is evident that the length of electrical oscillations of 20 to 20,000 per second is comparatively great. Hence to attempt to transmit without wires electrical oscillations set up primarily by the voice by means of a telephone transmitter, aerial wires about 15 miles in length would be necessary, which is not feasible.

For reasons that will become obvious it may not be amiss to refer here to the Van Rysselberghe system of Simultaneous Telegraphy and Telephony which for years has been in service on a large scale in this country. This system is briefly described in the article on TELEGRAPHY. Any action of the telegraph signals upon the telephone receiver is prevented by placing induction coils in the circuit which makes the rise and fall of the telegraph currents so gradual that the diaphragm of the telephone receiver is merely deflected and does not produce an appreciable sound. Upon this gradual rise and fall of the telegraph current is superposed the rapid vibrations of the speech waves set up by the telephone transmitter on the same wire. These minute vibrations do not affect the telegraph instruments. Quoting from Maver, W., 'American Telegraphy,' p. 347, "the theory of the operation of simultaneous telegraphy and telephony may be briefly outlined as follows: Assuming, for example only, the strength of the telegraph current to be 2,000 and that of the telephone current to be 1. If, while the diaphragm of the telephone receiver is attracted or in process of gradual attraction by a telegraph current of positive direction, a telephone current of similar direction be transmitted the total current will be suddenly increased to 2,001 and the diaphragm will be given a sudden minute impulse toward its magnet. Should then a negative telephone current follow, the telegraph current remaining as before, the current on the line will be suddenly reduced to 1,999 and the diaphragm by its own tension recedes rapidly from its magnet. In the actual operation of these systems many hundreds of pulsatory currents might be sent during the time taken to transmit one telegraphic signal, and thus, while the diaphragm is being gradually attracted to or is gradually receding from its magnet owing to variations in the telegraph current, at the same time it may be making hundreds of intermediate forward and backward movements of less amplitude, due to the variations of the line currents caused by the telephone transmitter in transmitting speech waves." In present day language the foregoing would be termed a modulation of the telegraph current in accordance with the variations of current due to voice waves.

It was recognized by the early workers in wireless telegraphy and telephony that if it should be found practicable to modify or modulate the high frequency ether waves utilized in wireless telegraph operation, it would be possible to transmit speech without wires to a distance approximating that of wireless telegraphy. A difficulty, however, in availing of high frequency electromagnetic waves for this purpose has been that as ordinarily obtained from the discharges of a condenser at the spark gap in wireless telegraphy such waves are intermittent and their amplitude is not uniform, but is quickly damped, as noted in the article WIRELESS TELEGRAPHY. Thus, in case of an alternating current generator developing a current of, say, 60 cycles, or 120 alterations per second, there will be 120 sparks per second at the gap if at each alternation the oscillation circuit is charged to sparking potential, which is not always the case. Assume that each discharge of the oscillation circuits gives rise to oscillations of a frequency of one million per second in that circuit, with a consequent wave length of 300 meters. The exact number of oscillations and wave length depends on the inductance and capacity of the oscillation circuit. (To conform to the word inductance the capacity of a circuit is now frequently termed capacitance). As the capacitance of the aerial is usually supplied by the aerial wires and is not readily variable, the frequency rate is varied by placing an adjustable inductance in the aerial circuit in the shape of a spiral coil of wire more or less of which may be inserted in or removed from the circuit. The capacity of the aerial is sometimes reduced, for short wave signaling, by placing a condenser (capacity) in the aerial circuit. In electrical diagrams a variable or adjustable condenser or inductance is conventionally indicated by an arrow through the apparatus. In the case in point if the oscillations were maintained throughout the interval between discharges there would be 8,334 oscillations per spark, that is, the quotient of 1,000,000 divided by 120. Since, however, the oscillations in such a circuit die out very rapidly, due to the damping effects mentioned in the article WIRELESS TELEGRAPHY, there are only two or three strong oscillations for each discharge in highly damped circuits and 10, 20 or 30 strong oscillations in less strongly damped circuits. Hence oscillations are only maintained during a brief interval between spark discharges, leaving approximately the one hundred and twentieth of a second between such discharges during which there are no oscillations in the oscillation circuit and at that time no waves are radiated from the aerial. In wireless telegraphy these intermittent or group oscillations after reception by a detector are observable in the telephone head receiver as a continuous tone or buzz which is broken into dots and dashes of the Morse alphabet by a telegraph key. If the attempt were made to superpose vibrations corresponding to voice waves upon these intermittent or broken oscillations, it is evident that portions of the voice waves set up by the transmitter would be lost.

Kennelly has mathematically demonstrated that speech might be transmitted telephonically with harmonics, or overtones, not exceeding 2,000 per second, but Fessenden has found by experiment that for satisfactory speech a frequency of at least 20,000 per second must be employed, otherwise disagreeable noises will be heard in the telephone receiver. Therefore, continuous or sustained oscillations of a fairly high frequency and uniform amplitude are essential upon which to superpose the voice frequencies for successful wireless telephony. To this end fairly successful efforts have been made by different inventors to produce a machine generator, or alternator, capable of delivering an alternating current of very high frequency notably by Fessenden, Goldsmith and Alexanderson. Owing to the mechanical difficulties of construction of such machines it is perhaps a question if they will prove commercially successful in general use. Nevertheless such machines have given and are giving good service in a number of instances. An idea of the difficulties of construction of high frequency alternators will be obtained when it is pointed out that to obtain 100,000 oscillations per second in a 600-pole rotor having a diameter of two feet, a speed of 20,000 revolutions per minute is necessary. Fairly full descriptions of high frequency machine generators will be found in books mentioned in *Bibliography*. Consult paper by Alexanderson, Proceedings American Institute Electrical Engineers (October 1919).

Another method of obtaining sustained electrical oscillations is known as the singing arc, due to Duddell, who discovered that when an arc lamp is in shunt with a capacity and an inductance of given proportions, a musical tone is set up in the arc. Ultimately Duddell obtained frequencies of 40,000 per second from this source. An explanation of this phenomenon is that when the shunt circuit is completed a current flows from the arc circuit into the condenser or capacity circuit which decreases the current flowing in the arc. This increases the electromotive force between the terminals of the arc, causing still more current to flow in the condenser circuit raising its electromotive force above the normal voltage of the arc. Consequently the condenser begins to discharge back into the arc, increasing the current therein and reducing the electromotive force between its terminals, when the reverse process is set up, and in this way continuous oscillations are maintained in the arc and shunt circuits.

When sustained oscillations are comparatively uniform in amplitude and their frequency is above audibility these oscillations are not heard in the telephone receiver. But, while the telephone receiver or at least the human ear will not respond to such high frequencies, if the amplitude or contour of the oscillation waves be modulated by speaking into a microphonic transmitter placed in the oscillation circuit, or in the aerial circuit of a wireless system, a telephone receiver will under proper conditions reproduce the speech spoken at the transmitter, virtually as speech is reproduced by modulating the amplitude of a beam of light, or a telegraph current in the case previously cited. The terms "radio frequency" and "audio frequency" are now commonly used to indicate the inaudible high frequency oscillations and the audible or low frequency oscillations, respectively, in wireless telephony.

The discovery of the oscillating arc paved the way for the use of sustained oscillations of high frequency and by means of modifications of Duddell's device much progress has been made in wireless telegraphy and wireless telephony. Such devices are now sometimes termed arc radio transmitters or arc converters.

An important improvement in the Duddell oscillating arc is that due to Poulsen. In the Poulsen arrangement the positive electrode of the arc is a water-cooled copper cylinder. The negative electrode is carbon. The arc is placed in a strong magnetic field which tends to blow out the arc, after the Elihu Thomson effect. The source of current supply for the arc is a direct current generator supplying from five kilowatts to 100 kilowatts at 500 to 600 volts. The arc converts the energy of the direct current machine into alternating currents of a frequency of say 60,000 per second. The practical efficiency of the arc converter is 33 per cent to 50 per cent of the input. For further interesting details of this arc converter and its utility in Wireless Telegraphy, consult an article in *Electrical World* (30 Aug. 1919, p. 452).

A very important source of sustained high frequency oscillations in wireless telegraphy and telephony of more recent origin is the three electrode high vacuum tube to which more extended reference will be made herein.

A great advantage of sustained oscillations in wireless telephony and wireless telegraphy also is that the property of resonance may be more fully availed of than when more or less intermittent oscillations are employed. It may be noted that in wireless telegraph and wireless telephone operation the receiving apparatus is practically the same. In wireless telegraphy the full effect of the radiated waves from maximum to zero is available, whereas in wireless telephony only a small portion of the emitted wave energy is available, namely, that due to the modulation of the wave energy caused by the action of the telephone transmitter, estimated to be about 5 per cent of the total energy radiated. This, however, in view of the amplifying powers of the high vacuum tube detector is not now of so much importance. See TELEGRAPHY, WIRELESS.

De Forest Wireless Telephone.— In Fig. 2 is outlined an arrangement of the De Forest wireless telephone system employed in 1909 and possibly prior thereto. A singing arc *a* is employed as the source of sustained high frequency oscillations. *C* is a variable condenser, *L* is a transformer or tuning coil, the secondary soil *s* of which is in series with the aerial wire *A*, and a microphone transmitter *M*. *a* is an arc with copper-carbon electrodes, burning in the flame of an alcohol lamp *m*. The arc is supplied with a 220 or 440 volt direct current supplied by a generator indicated at *G*. *K K* are choke coils, or inductances, in the supply circuit, used to shut out the high frequency oscillations of the arc from the generator. The arc a sets up in the circuit a, C, p sustained oscillations that are radiated as electric waves from the aerial wire A. Speech spoken into transmitter M modulates the amplitude of these waves practically in a manner equivalent to the action of the voice currents in the Van Rysselberghe simultaneous system of telegraphy and telephony upon the telegraph currents therein. There is, of course, the difference that in the latter case it is the slow telegraph impulses of current that are modulated by the voice currents, whereas in the case under consideration it is the high frequency radio currents that are modulated by the voice currents. It is now the practice to term the modulated high-frequency waves employed in wireless telephony, and it may be added, in wire telephony also, carrier waves, since they virtually carry the voice waves.

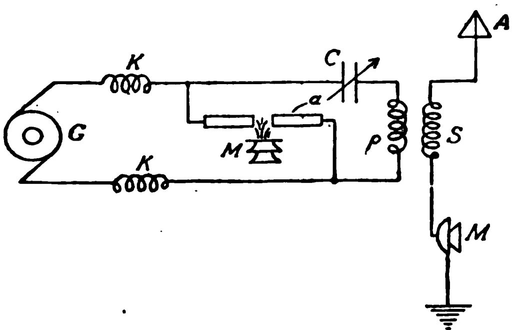


FIG. 2.— De Forest Wireless Telephone Transmitter Circuit.

The receiving circuits of the said De Forest telephone system are shown in Fig. 3. A is the aerial, L is the tuning coil, C is a variable condenser. The detector employed is the De Forest audion. (See TELEGRAPHY, WIRELESS). It comprises a tantalum lamp filament F, a grid G of No. 22 platinum wire and a small platinum plate P, all within an exhausted bulb b, resembling a six-volt incandescent lamp. The filament is lighted or heated by a three-cell storage battery B, the current strength of which is regulated by a variable resistance r. PB is a potential battery of 10 to 30 volts, adjustable as to potential by a potentiometer, not shown. One terminal of the oscillation circuit L, C is connected to the grid, the other terminal to the filament, as in the figure.

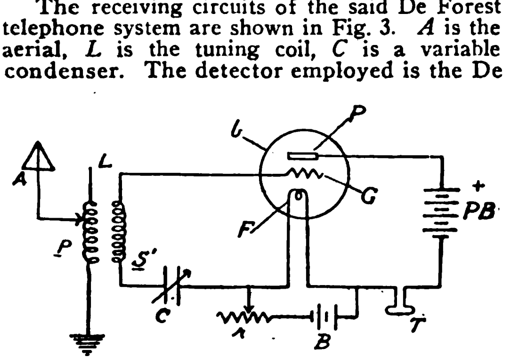


FIG. 3.—De Forest Wireless Telephone Receiver.

When the heating battery and the potential battery are properly adjusted the audion is very sensitive and produces amplified sounds in the telephone receiver. The incoming high frequency, or radio sustained oscillations, as stated, do not perceptibly affect the telephone receiver owing to their regularity, uniformity of amplitude and high frequency, but the modulations of the amplitude of the incoming audio oscillations due to the microphone transmitter, being within the range of the human ear, are heard in the telephone receiver as articulate speech.

Wireless Telephone Transmitters.— The transmitters for this work necessarily require high current strength in the transmitter circuit. This develops heat in the carbon granules of the microphone transmitter, which leads to packing of the carbon. This impairs or stops the transmission of voice waves. The packing can be broken up by tapping the transmitter at suitable intervals, and De Forest provides a special device for this purpose. In other cases a device consisting of a number of tubes leading from a single mouthpiece to a number of transmitters, all acting upon the one circuit, is employed. Fessenden uses a special transmitter for this work, by means of which a current strength of 15 amperes is modulated successfully. For aeroplane service during the war transmitters of special design were found to be necessary if successful results were to be obtained. In this service, besides difficulties due to packing, precautions had to be taken to annul engine, propeller and other external noises. To this end the diaphragm of one type of transmitter is so constructed as not to respond readily to air vibrations below 200 or above 2,000 per second. In another type a perforated plate is interposed between the speaker's mouth and the diaphragm of the transmitter, which device baffles the movement of extraneous sound waves toward the diaphragm while the voice waves spoken directly into the mouthpiece are not impeded. Still another device employed in this service consists in leaving the back of the transmitter open in such a way that exterior noises impinge on the back and front of the diaphragm of the transmitter with equal strength, effecting no result, whereas the voice waves hit the diaphragm in one direction only and thus set up the required variations in the transmitter circuit, even although at such times the pilot or observer cannot hear his own voice.

Three Electrode Vacuum Tube Oscillator.— As previously intimated the De Forest three electrode vacuum tube is now used as a source of high frequency sustained oscillations, and many different arrangements of circuits have been designed to utilize this remarkable feature of these tubes, now in practice frequently designated vacuum tubes or VT's. One such arrangement of circuits to obtain sustained oscillations is shown in simple form in Fig. 4, termed a vacuum tube oscillator. It illustrates the «feed back» or «regenerative» coupling of circuits, perhaps first devised by Armstrong. F is the usual filament, G is the grid, P is the plate of the tube proper. HB is the heating or lighting battery. r, r' are regenerative or feed-back tuning coils. C is a condenser across the filament grid-circuit. Closing the circuit or jarring the tube will cause an initial impulse or oscillation in the grid-plate circuit, including coil r'. This oscillation in turn reacts on the grid-filament and r circuit, which again reacts on the former circuit, thereby producing a feed-back or regenerative oscillating current in the tube that may be termed self-perpetuating. After a brief interval a steady sustained oscillation is produced. The coils r, r' and condenser C are adjusted to oscillate at a desired frequency in the usual way. By means of this tube oscillations from one-half cycle to 20,000,000 per second are now obtainable.

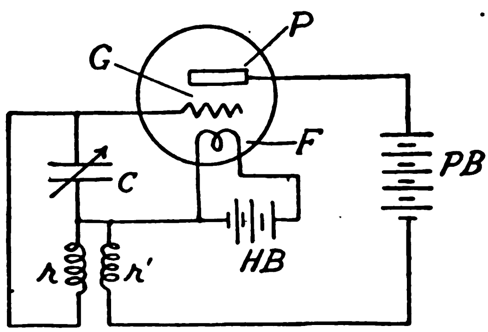


FIG. 4.—Vacuum Tube Oscillator.

It has been noted by another writer in expounding the oscillating feature of these tubes that "in order to set tube circuits into a state of radio frequency oscillation it is necessary that the connections be so made that the grid end of the grid inductance will be alternately negative and positive, as the plate end of the plate inductance is positive and negative. When the grid and plate radio frequency circuits are coupled with the proper phase relation any variation in voltage in either the grid or plate circuits will cause minute disturbance in the oscillation circuits, setting them into oscillation at whatever frequency they may happen to be adjusted to. For example, a slight variation of voltage in the plate circuit by any means whatever will cause its resonant circuit to oscillate at radio frequency, and the resultant current will act upon the grid circuit, setting it into action at the same frequency. The resulting radio frequency fluctuations of the grid potential will act upon the plate at the right time to keep the plate resonance circuit in a state of oscillation, and this state of affairs will continue so long as the proper supply of voltage and filament current is maintained, but not otherwise. The tube is able to generate alternating currents because of its amplifying properties. The energy delivered to the grid circuit in accordance with the actions just outlined will gradually increase in value until a maximum is reached, which is the maximum output the valve is capable of delivering." Consult *The Wireless Age*, June 1919, p. 15, article on "Wireless Telephone Transmitter for Seaplanes."

In general De Forest gives the explanation of the vacuum tube oscillator as follows: "There is only one oscillating circuit. This circuit is such that a sudden change of potential impressed on the plate produces in turn a change in the potential impressed on the grid of such a character as to produce in its turn an opposite change of value of potential on the plate. Thus the to and fro action is reciprocal and self-sustaining."

In some respects the operation of the vacuum tube oscillator is perhaps analogous to the oscillator previously described. Another example of a self-perpetuating oscillation circuit is that due to placing a telephone receiver before the mouthpiece of a telephone transmitter when a shrill whistle or howling is often established. This phenomenon is especially noticeable in the transmitter and receiver of the acousticon type. This effect is seemingly due to a series of reactions somewhat similar to, but much more complex than those that occur in an electric door bell, another device which self-perpetuates its own vibration; when its circuit is closed by the push-button. In the case of the telephone howler let us assume in explanation of its action that a movement of the diaphragm of the receiver toward its magnet tends to weaken the air pressure on the diaphragm of the transmitter, and hence weakens the pressure of the carbon of the transmitter. This causes a weakening of the current allowing the diaphragm of the receiver to fall away, with the further result that the air column is compressed, this tending to increase the pressure on the carbon again and also increasing the current strength in the circuit, whereby the diaphragm of the receiver is again attracted, which actions are repeated over and over. Investigation of this phenomenon indicates, as might be expected, that it is dependent upon the fundamental set of vibration of the receiver and transmitter, the length of the air column enclosed between them and also the oscillation period of this circuit. The above references to the attraction of the diaphragm of the receiver and to its falling away are perhaps rather broad terms, when it is considered that as near as can be calculated the amplitude of vibration of the said diaphragm in reproducing speech is about the one twenty millionth of an inch. While this phenomenon has no direct bearing on the vacuum tube oscillator it is interesting as somewhat analogous thereto and hence may tend to simplify the explanation of the device.

Colpitts' Vacuum Tube Oscillator, Modulator and Repeater.— In Fig. 5 is shown an arrangement due to Colpitts of a vacuum tube and telephone transmitter with other circuits and apparatus for providing a high frequency vacuum tube oscillator, modulator and repeater of radio and audio frequencies. In vacuum tube operation the circuits into which energy is put is termed the input circuits; those that give out energy, the output circuit. In Fig. 5 the input circuit consists of the grid G of the vacuum tube VT, modulator coil r', battery B and filament F, as indicated by the letter i. The output circuit indicated by letter o consists of the plate P, filament F, condensers C C and the primary coils of repeating coils or transformers T, T', and battery B', which battery supplies current to plate P, through an inductance or choke coil K; b is the usual heating battery. The secondary winding S of the repeating coil or transformer T' is connected through condenser C' with the input circuit. The primary winding p of transformer T' is in series with the secondary of another transformer T'' which latter is coupled with the telephone transmitter circuit *TC* as shown. The arrangement acts as a generator of high frequency currents by reason of the inter-action of the input and output circuits through the transformer *T'* and the circuit *S C'*. These high grequency currents are modulated by the audio frequency currents due to the operation of telephone transmitter *TC* through the transformers T^2, T^3, and are transmitted by the transformer or repeating coil *T* into the line or aerial *A* to which the secondary coil of *T* may be connected. Consult Colpitts' United States Patent No. 1,137,884, 1915.

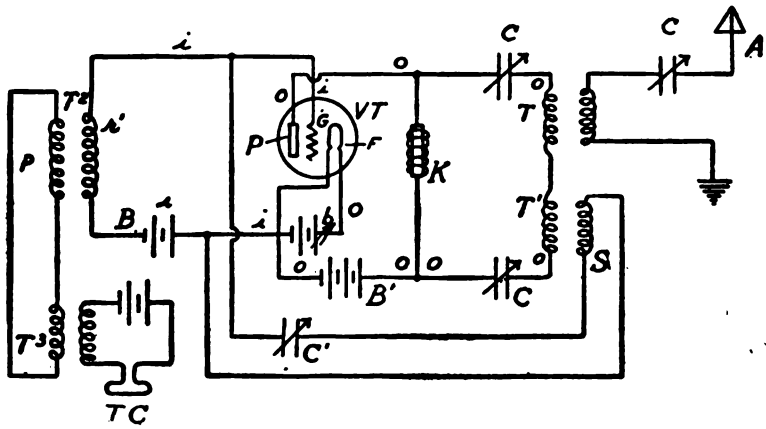


Fig. 5.—Colpitts' Oscillator, Modulator and Repeating Device.

Two or More Stage Vacuum Tube Circuits.— A combination of a transformer and amplifier tube is termed a one-stage amplifier. The number of transformers and amplifiers, in series can be further increased, but since static and other stray currents are also amplified a practical limit is soon reached. In practice seven stage amplifiers have been successfully utilized and a much greater number of amplifiers in series have been employed experimentally.

In Fig. 6 is shown a vacuum tube receiving circuit with a detector tube *VT* and a two-stage amplifier method, *T' VT'*; T^2 VT^2, employed in the United States Signal Corps service. The incoming oscillations are detected by tube *VT* and are successively transformed and amplified by transforming *T'*, vacuum tube *VT'*, and T^2 V^2; telegraph or telephone signals being received in the telephone receiver *TR*.

As noted in an article on «Radio Frequency Amplifiers» (in *Electrical World*, p. 570, 22 March 1919), «to build a reliable and efficient amplifier of more than three stages at any one frequency is practically impossible, since very grave difficulties are met with in keeping it from howling or oscillating. It is, however, quite practicable to amplify a radio signal at its radio frequency, pass it through a detector tube and then amplify the resulting audio frequency current. This not only gives the increase due both to the radio and the audio frequency amplifiers, but in addition increases the detector tube efficiency since within limits the efficiency of detection increases with the signal strength. Thus the receiver usually works out best in seven stages, three raido, one detector and three audio stages. Properly designed sets of this kind operated non-oscillating and without regeneration, will give signals more than 10^{14} times as strong as would be obtained with a simple one tube detector. By using a regenerative feed back much higher amplification can be realized, but the operation becomes less stable.»

The degree of amplification due to the vacuum tube amplifier varies under different conditions of battery, circuit connections, etc. In the case of an amplifier made for the United States Signal Corps, the power of the output signal was from 40,000 to 60,000 times that of the input signal. In general it may be taken that the increase in audibility is according to the square of six per amplifier. Thus if one amplifier increases audibility six times, two amplifiers will increase it 36 times, and so on. It has been stated that by «the use of successive vacuum tube amplifications, energy increases of 10,000,000,000,000 times have been obtained and that a six stage amplifier permits the feeble energy derived from a telephone receiver

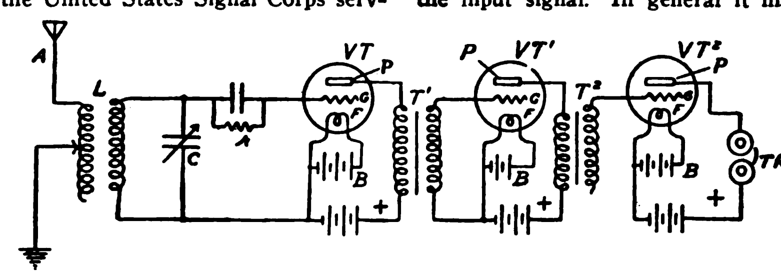


Fig. 6.—Receiving Circuit with Detector and Two-Stage Amplifier.

when employed as a transmitter to light an ordinary tungsten lamp, or to produce a sparking potential of several thousand volts." The amplifying power of the vacuum tube is, however, not an instance in which something is seemingly obtained for nothing. In this respect it is not comparable to the microscope or telescope. Rather, as pointed out by Batsel, its amplifying effects are obtained in a manner analogous to the increase of power in a direct current generator due to an increase of current or potential in the field circuit of the machine, which in turn increases the density of the magnetc field in which the armature rotates. The increased power in the dynamo output is disproportionately greater than the increase of current in the field circuit and is supplied by drawing upon the mechanical energy that revolves the shaft of the dynamo. Analogously the batteries that supply the heat for the filament and the electric potential for the plate are drawn upon to supply the power developed by the vacuum tube. In the case of the direct current generator the power is controlled by the magnetic field; in the vacuum tube the output is controlled by the grid potential through the agency of an electric field.

The transmitting and receiving vacuum tubes employed in wireless telegraphy and telephony are differently constructed and require varying amounts of current. Thus one type of receiving tube used by the United States Signal Corps requires for filament operation 1.1 ampere supplied by a four-volt storage battery, while the plate circuit is supplied by a 30-volt dry battery of 15 cells. The filament in the transmitting tube takes normally 1.36 amperes at seven volts. The battery for the plate circuit of this tube ranges from 250 to 350 volts. The power output of this tube is three to five watts. Consult article by Bown (*Electrical World*, 22 Feb. 1919).

Wireless Telephony in Aerial Service.— The exigencies of the Great War led to rapid development in wireless telephone apparatus and methods for army and navy needs in this country and abroad. There was especial need for wireless telephony in the aerial service and great progress was made in meeting these demands. For the latter purpose apparatus of minimum weight was necessary. The dimensions, for example, of a complete outfit for the use of the United States Signal Crops, containing vacuum tubes, transformers and plate circuit dry batteries are nine inches by seven inches by five inches, and it weighs eight pounds. The input transformer used in this set is of the shell type, wound with 6,000 feet of No. 40 enameled wire with paper insulation between the layers of wire, and weighs two pounds.

In Figs. 7, 8, respectively, are given illustrations of transmitting and receiving types of three electrode vacuum tubes used by the United States Army and Navy signaling departments in the late war. In Figs. 9, 10 are illustrations of airplane transmitting and receiving wireless telephone sets utilized by the United States Signal Corps. Wireless telephone communication between flying machines in the air and between the planes and ground stations; also by means of wire telephony between the men in the airplane itself, was daily

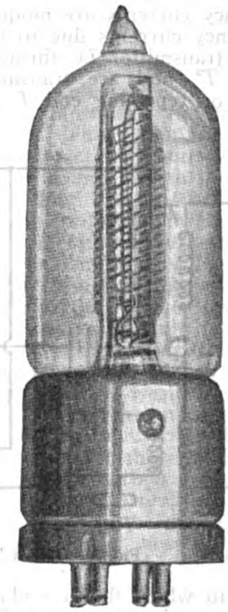


FIG. 7.—Receiving Type Vacuum Tube.

becoming of more importance toward the close of the war, and many valuable improvements were developed to facilitate this communica-

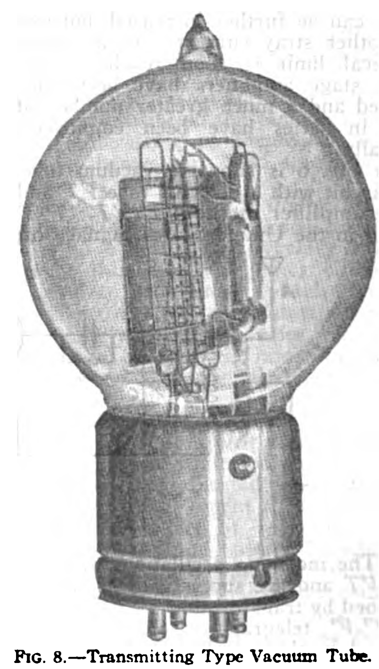


FIG. 8.—Transmitting Type Vacuum Tube.

tion. Consult a paper on "Radio Telephony" by Craft and Colpitts (American Institute Electrical Engineers, 21 Feb. 1919).

Multiple Wireless Telephony.— In wire telegraphy the term duplex telegraphy signifies a system in which two messages are sent over one wire simultaneously in opposite directions. By diplex telegraphy is meant the sending of two messages in the same direction over one wire simultaneously. The term multiplex telegraphy usually covers telegraph systems by which more than two messages are transmitted over one circuit at the same time in either direction. In wireless telegraphy the term «duplex telegraphy» is applied to means by which two wireless messages are sent in opposite directions at once from two wires on one supporting tower, or preferably from two wires on separate towers, and again preferably with the respective transmitting and receiving aerials separated a distance of 25 or 50 miles, in which latter case the transmitting and receiving apparatus are connected by land wires, thus making it possible to localize the transmitting and receiving operators in one room. This is termed remote or distant control. The actual adjustments of the wireless apparatus are made by attendants at the transmitting and receiving antennæ. Utilizing remote control methods during the late war, the high-power wireless transmitter stations at Annapolis, Md., Tuckerton, N. J., New Brunswick, N. J., and Sayville, L. I., were operated by four operators in one room in the Navy Department building, Washington, D. C.

The term multiplex wireless telephony may also be utilized as mentioned in the case of duplex wireless telephony, but preferably it refers to the sending of two or more wireless messages simultaneously from different antennæ at nearby stations, say, ships of a fleet, and their reception on the antennæ of different ships of a fleet at a distance. One of the best known multiplex telephone systems for this purpose is due to R. A. Heising. The description of this system will perhaps be simplified by the interpolation of a brief allusion to the Gray Harmonic Multiplex Telegraph system, formerly in use on land lines.

The Gray Harmonic Multiplex Telegraph.— By means of this system it is possible to transmit over one wire simultaneously four or more messages by means of electrical vibrations. In this system four tuning forks of different rates of vibration, say, 264, 320, etc., per second, are each given control of a battery by contact points suitably fixed on the forks. These batteries are arranged in series in a main line circuit. The tuning forks are kept in constant vibration by an electromagnetic device similar to that of the ordinary electric door bell, the forks being used as the armature of the magnet. When in operation these forks open and close the circuits of their respective batteries at a rate corresponding to the fundamental vibration of the forks, and thereby set up four different trains of electric impulses in the main line circuit, of frequencies equal to those of the respective vibrating forks. A Morse telegraph key is arranged to control the impulses set up by each fork in such a manner that a series of short and long electric pulsations corresponding to the dots and dashes of the Morse telegraph alphabet may be transmitted over the main lines by each key.

At a receiving station four electromagnets are placed in series in the main line circuit. The armatures of these instruments are iron reeds, fastened at one end, and attuned to vibrate at rates corresponding with their respective vibrating forks at the transmitting station. Hence, each reed will select and respond only to the pulsations of current transmitted by its respective vibrating fork. Contact points controlling a local current are also attached to the armatures of the receiving magnets and by this means the transmitted dots and dashes are received by a Morse telegraph sounder in practically the usual way.

Obviously, when all of these differing rates of current impulses are being transmitted at one time over one wire the resultant composite wave must be complex to a degree. Yet the Gray Harmonic telegraph system was in successful operation for several years between New York and Chicago on the lines of the Postal Telegraph Company. Indeed the degree

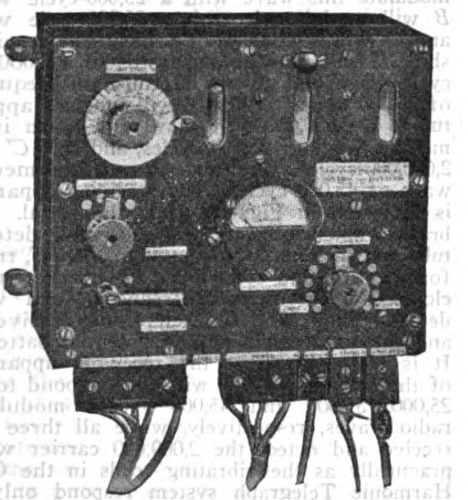


FIG. 9.

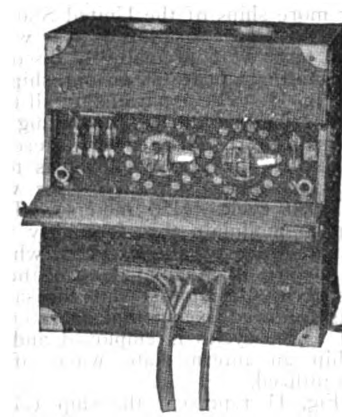


FIG. 10.

Airplane Transmitting and Receiving Set adopted by the United States Signal Corps.

of complexity of the resultant current referred to did not end with the operation of the functions outlined in the foregoing remarks. For, in addition to the four pulsatory circuits mentioned, an ordinary Morse duplex system was superposed on the vibrating system, this giving a sixtuplex telegraph system capable of transmitting six messages over one wire simultaneously.

The Heising Multiplex Wireless Telephone System.— In this system an arrangement measurably analogous to the foregoing is employed for setting up electric oscillations of different frequencies, which differing rates of oscillations are simultaneously radiated as a compound wave in space from the aerials of nearby transmitting stations and are selected and received at the receiving stations by suitably attuned wireless apparatus, in a manner to be described.

This system was installed experimentally on three or more ships of the United States navy, but owing to the declaration of war with Germany the tests were prematurely discontinued. The transmitting apparatus on one ship is outlined in Fig. 11. The apparatus on all the ships was similar, but certain of the tuning circuits on each ship were adjusted to different rates of oscillation. The plan employed is to transmit from the three ships a carrier wave of say 2,000,000 cycles (150 meters). Then on one ship to modulate this frequency with an intermediate wave of 25,000 cycles, which frequency in turn is modulated with the waves due to speech. On another ship the same procedure is followed except that an intermediate wave of 35,000 cycles is employed and on the third ship an intermediate wave of 45,000 cycles is utilized.

Let Fig. 11 represent the ship (A) using wave modulates at R the amplitude of the 25,000 cycle frequency set up by the oscillator-tube VT'. In turn this modulated 25,000 cycle frequency after amplification in power tube VT^2 is, through transformer T^2 caused, at condenser C, to modulate the 2,000,000 cycle carrier wave developed by oscillator VT^3. This doubly-modified carrier wave after increased power amplification by the tube VT^4 is delivered by the transformer T^4 to the antenna A. The batteries and other devices used in this system are not shown in the figure.

To avail of this arrangement each of the three ships or other stations equipped with this apparatus will transmit a carrier wave of 2,000,000 cycles. But one ship, say A, will modulate this wave with a 25,000-cycle wave. B will modulate it with a 35,000-cycle wave, and C with a 45,000-cycle wave. The receiving ship A' will tune his apparatus to a 2,000,000-cycle wave and to an intermediate frequency of 25,000 cycles. Ship B' will tune his apparatus to a 2,000,000-cycle wave and to an intermediate wave of 35,000 cycles, and ship C' to a 2,000,000-cycle wave and to an intermediate wave of 45,000 cycles. The receiving apparatus is indicated in Fig. 12. A is the aerial. The bracket m encloses the 2,000,000-wave detector tube and the appropriate tuning coils TC, transformers RC and condensers C. Bracket n encloses the intermediate frequency and voice detector tube VT', the telephone receiver R and the usual filament and potential batteries. It is plain then that the receiving apparatus of the ships A', B', C' will only respond to the 25,000, 35,000 and 45,000 speech modulated radio waves, respectively, while all three will receive and detect the 2,000,000 carrier wave, practically as the vibrating reeds in the Gray Harmonic Telegraph system respond only to

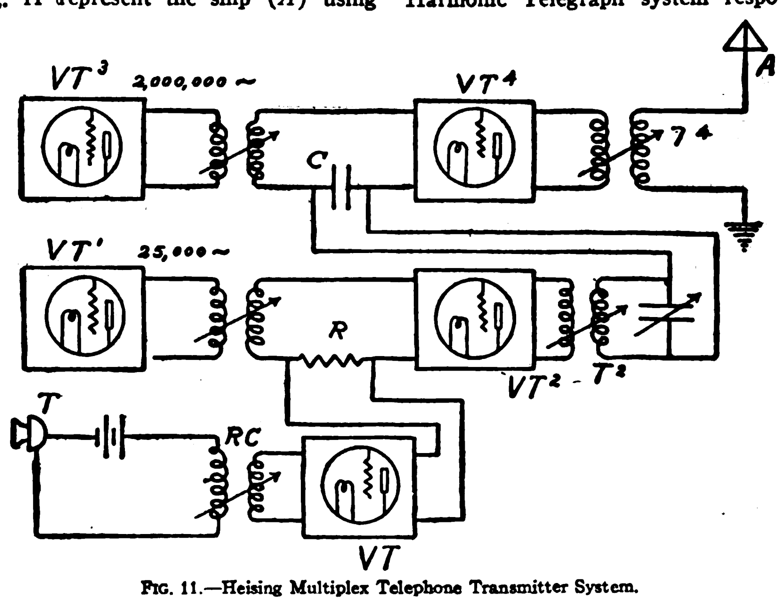


FIG. 11.—Heising Multiplex Telephone Transmitter System.

the speech modulated wave of 25,000 frequency. T is a microphone transmitter. The speech waves set up by this transmitter is repeated by the transformer or repeater coil RC into an amplifier VT. This amplified speech the particular train of impulses to which they are attuned.

This system of non-interfering multiplex wireless telephony is not, however, limited to the sending of three messages or conversations simultaneously in the same neighborhoods. For, by using carrier waves of say, 189 and 239 meters in length, in addition to the wave length of 150 meters, and by modulating each of these two additional carrier waves with intermediate frequences of 25,000, 35,000 and 45,000 cycles it will be feasible to carry on nine separate wireless conversations simultaneously between the ships equipped and placed as indicated in the foregoing.

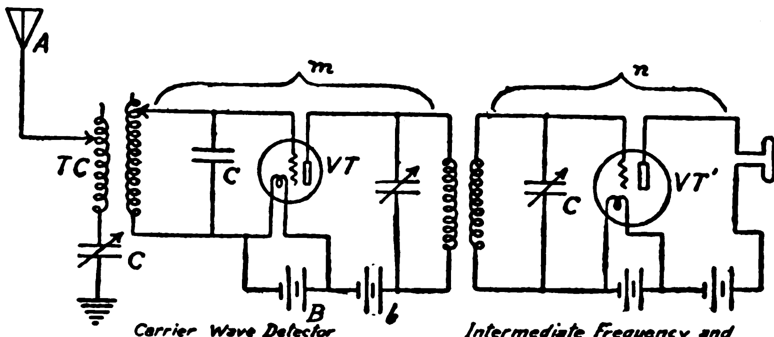


FIG. 12.—Multiplex Wireless Telephone Receiving Circuits.

Tests with apparatus somewhat similar to that just described showed that two-way wireless telephone conversations could be carried on between ships at a distance of about 40 miles, the power of the outfits being low. The limit of speaking distance was about 150 miles. By two-way conversation is meant the ability to converse in either direction, one speaker at a time on one circuit. Apparatus to permit this two-way conversation was provided on the ships. The object in resorting to the short-wave lengths of 150 and 189 meters in the tests just described was to avoid interference or clashing with the regular wireless telegraph operation of the ships of the navy which use wave lengths of 600 to 1,200 meters.

In Fig. 13 is shown an arrangement of amplifying and power tubes such as referred to in the description of Fig. 11. *G* is a generator of high frequency oscillations which after transformation by coils *RC* may be modulated by the microphone transmitter *T*. These modulated oscillations are amplified by the tube *VT*, the output circuit of which is coupled through transformer *RC'* to the input circuits of a battery of two power vacuum tubes *VT'*, the output circuits of which in turn are coupled through transformer RC^2 to the input circuits of a battery of three power tubes VT^2. Similarly the output circuits of the latter tubes are coupled through the transformer RC^3 to the aerial *A*, from which the modulated high frequency oscillations amplified and increased in power are radiated into space. *BB* in the figure indicate the usual heating and potential batteries. The power tubes, it will be noted, are connected in quantity or multiple and not in series or cascade as in the case of amplifier tubes. See Fig. 6.

Long Distance Wireless Telephony.—An epochal series of experiments in long-distance wireless telephony was in 1915 conducted by the American Telephone Company in conjunction with the Western Electric Company and representatives of the United States navy and the French army. The most notable of these tests were perhaps those made between Arlington, Va., and the Eiffel Tower, Paris. Tests had been previously made between Arlington and Darien, 2,100 miles oversea, and between Arlington and Mare Island, near San Francisco, 2,500 miles overland. In the Arlington-Darien experiments speech was transmitted from New York City by land lines to Arlington, whence it was transmitted by wireless telephony to Darien. In the Arlington-Paris experiments difficulty was found in obtaining the use of the Eiffel Tower station, owing to the exigencies of the Great War which was then in progress. In these tests the Eiffel Tower station was used only for receiving. On 22 Oct. 1915, however. speech transmitted from

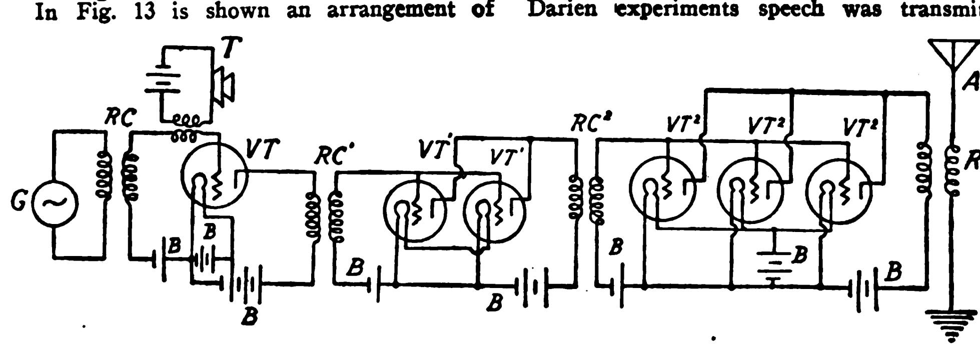


FIG. 13.—Transmitting Circuit Showing Amplifying and Power Vacuum Tubes.

Arlington was clearly received in Paris, a distance of 3,600 miles. The radio-wave length employed was 6,000 meters. The antenna current employed at the Arlington station was about 50 amperes. The speech transmitted on this and other occasions was also received, and the voice of the speaker clearly recognized by the wireless operator in Honolulu, 4,500 miles from Arlington.

The general plan of transmission adopted at Arlington was somewhat similar to that indicated in Fig. 12, but of course the number and capacity of the amplifier and power tubes used at Arlington was greatly in excess of that used in shipboard or ordinary wireless telephone practice.

The Future of Wireless Telephony.— In view of the rapid development of wireless telephony within the past 8 or 10 years it would be unwise to attempt to place a limitation upon the extent of the use of this art within the next decade. The possibility of transmitting wireless telegraph messages a distance of 12,000 miles, namely, from Carnarvon, Wales, to Sydney, Australia, has been demonstrated (2 Oct. 1918). Likewise the possibility of transmitting speech by ether waves a distance of 4,500 miles has been shown. These results are obtainable by the use of the vacuum-tube oscillators and amplifiers. As a distance of 12,000 miles is half way around the earth and as the ether waves in traveling that distance traverse both sides of the earth, it follows that this is equivalent to transmitting a message from one point to any other point on the earth. Since also it appears evident that by means of the three-electrode vacuum tube speech may be transmitted to any distance reached by radio-telegraph waves, it would seem that under favorable conditions it may be said that world-wide wireless telephony is now a possibility.

The high cost of very high-power vacuum tubes together with their low efficiency and limited durability is at present, however, likely to militate against their general use, but improvements in methods of construction of this apparatus will doubtless reduce its cost and increase its durability. The existing need of high and very expensive aerial wires in long distance wireless telegraphy and telephony is also a limiting factor to the extensive employment of those arts to very long distances.

Some of the chief obstacles to the extensive and successful use of wireless telegraphy and telephony in the past have been those due to statics and interference between or clashing of signals from different sending stations at nearby or even at remote stations. A great forward step toward the solution of the statics problem is that due to the Weagent anti-static devices. (See TELEGRAPHY, WIRELESS). The interference problem is still to be solved.

As already noted, by the use of selective tuning devices which only transmit and respond to waves or oscillations of a certain frequency, stations may cut out waves of other frequencies and thus avoid interference. Thus by the use of a standard wave length for certain circuits, as, following land telegraph practice, the ether route used by different wireless stations may be termed non-interfering; ether circuits may be and in fact are established very generally at the present time. Thus the regular wave lengths for a given trans-Atlantic circuit may be set at, say, 10,000 meters. Other stations using that wave length in the vicinity of that circuit to which the 10,000-meter wave length is assigned, would set up interference or clashing of signals. It is known, however, that a difference of 300 to 400 meters in the wave length is ample to avoid interference between such stations. For instance, a circuit employing a 10,000-meter wave length could operate side by side with a circuit employing a 10,400-meter wave length. For long-distance wireless telegraph and telephone operation, or, in other words, for high-power station work, long wave lengths are essential. The present minimum and maximum available wave lengths are, say, from 10,000 to 20,000 meters for long distance signaling. Since the signals from the very high-power stations are now received all over the world, it is obvious that if a difference of, say 400 meters, is required to prevent interference between any two such wireless circuits, the total number of available world-wide circuits would be limited to say 25.

It may be noted that for short-distance wireless signaling a difference in the respective wave lengths of about 20 meters is found sufficient to prevent interferences between circuits. Even in short distance signaling, however, were all stations to adhere rigidly to an allotted wave length in any designated zone the number of available wave lengths would ultimately be reached. While the foregoing conditions continue the limitations to wireless telegraphy and telephony will exist.

It is, however, not unlikely that improvements in this branch of electrical signaling will render it possible to operate transoceanic wireless telegraphy and telephony on a much closer margin than 400 meters. Indeed it has been noted by Alexanderson in the paper referred to that by improved arrangements of apparatus and circuits it will be possible to operate such circuits with a difference of but 1 per cent of the total frequency, instead of 4 per cent as at present. This would make it possible to increase the number of transoceanic circuits to, say, 100, roughly speaking. Again, by means of improved methods of directive signaling the number of parallel wireless circuits on one wave length will be increased by five. These improvements together with an increase in the speed of signaling to 100 words per minute generally, instead of 20 words as at present, will, it is estimated, increase the total capacity of the radio transoceanic traffic of the world 175 times.

In wire telephony interference of this nature does not occur, as measures are taken to prevent such interference (termed inductive interference between circuits) by using two parallel wires suitably transposed for each telephone circuit. (See TELEPHONE). The effect of induction between parallel Morse and printing telegraph circuits is not pronounced inasmuch as the receiving instruments employed on those systems are comparatively insensitive to weak induction currents from other lines.

Notwithstanding the real difficulties in the way of what may be termed universal wireless telephony for social, commercial and other purposes it is confidently expected by competent telephone engineers and inventors that its ultimate consummation is not beyond the possibility of practical realization. In the meantime wireless telephony if only available, commercially, for comparatively short distances, obviously could be installed to great advantage in the officer's room of every ship that floats ocean, lake, river or harbor, because of the fact that telephony requires no specially trained operator.

Bibliography.— Bucher, 'Vacuum Tubes in Wireless Communication'; Fleming, 'Radio Telegraphy and Radio Telephony'; Goldsmith, 'Radio Telephony'; Maver, 'Wireless Telegraphy and Telephony.'

WILLIAM MAVER, JR.,
Author 'American Telegraphy and Encyclopedia of the Telegraph.'

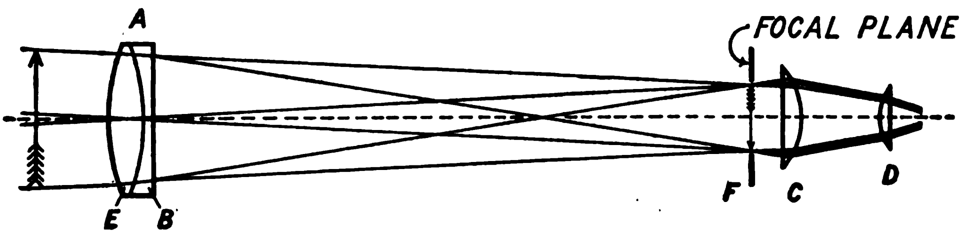


FIG. 1. — Astronomical Telescope.

TELEPHOT, or TELEPHOTE, any one of several theoretical instruments designed to reproduce scenes at a distance by photography and the aid of electricity. Telephotography has been an interesting field for inventors, but no commercially successful machine has been developed.

TELESCOPE. The telescope is an optical instrument by which the image of a distant object is magnified so that it may be examined as if it were but a fraction of its actual distance from the observer. This instrument was invented by the Dutch optician, Lippershey, early in the 17th century. The first use of it for astronomical observations was made in Florence, by Galileo, who in 1609 invented the type known as the Galilean telescope. His first instrument was constructed of two spectacle lenses set at the ends of a section of a leaden organ-pipe. Its power was three diameters. A second instrument had the power of eight diameters and a later one 30.

The many and widely varying forms of telescopes may all be grouped simply as tubes (Milton, seeing Galileo's in Florence, called it the «Optik Tube»), in which are placed the several combinations of lenses or reflectors; each combination, however, producing the one result, namely, first, gathering the light from the object and concentrating it at the focus in a brilliantly illuminated but small image; and, second, magnifying this image with a microscope called an eye-piece. One of the common types is the refracting astronomical telescope (Fig. 1), in which A is the object-glass or objective, and F the focus, where the small image is formed. The two lenses, C and D, form the microscopic eye-piece, which magnifies this image. The first reflecting telescope was the Gregorian, invented in 1663 by James Gregory. It has not survived. Fig. 2 represents the reflecting astronomical telescope as invented in 1669 by Sir Isaac Newton, and called the Newtonian Reflector. In this the light traverses the entire length of the tube, at the lower end of which it strikes the concave reflector A, which sends it back as a cone of rays to the diagonal reflector B; thence it travels to the focus F, where it is magnified by the eye-piece E, as in the refracting telescope. Fig. 3 represents the most popular form of reflecting telescope, called the Cassegrainian, invented by Cassegrain in 1672. The optical principles here are the same as in the Newtonian form except that the convergent cone of rays from the mirror A is intercepted by a convex reflector B and sent back through an opening in the centre of the mirror A to the focus F, where the image is magnified by the eye-piece as before. The Herschelian reflector was invented by Sir William Herschel (q.v.) in 1780. His great telescope, built in

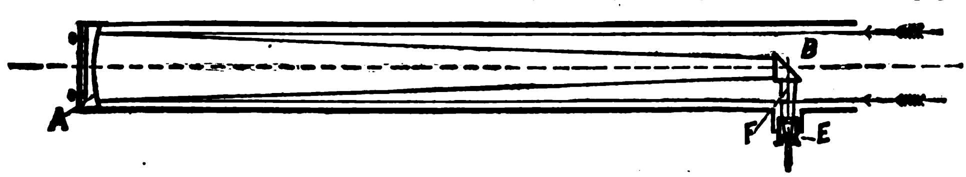


FIG. 2. — Newtonian (eye-piece on side of tube).

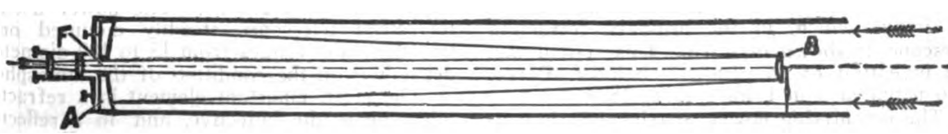


FIG. 3. — Cassegrainian (secondary mirror convex).

1789, had a mirror 48 inches in diameter and a tube 40 feet in length.

In these forms of telescope the image of the object as seen through the eye-piece is necessarily inverted, which is, of course, unimportant in astronomical observations, but is a defect to be overcome in the terrestrial instrument. The most common type of terrestrial telescope is the Spy Glass (Fig. 4). The objective A has the same office as in the refracting astronomical telescope, and forms an illumined image of the object at the focus F. This image is then magnified by a compound eye-piece made up of several lenses B, C, D and E, which carry the light to the eye in such manner as to erect the image and show it in its natural position. Fig. 5 represents the Galilean telescope, which is the same in principle as the ordinary opera glass. In this case the objective A condenses the light from the object observed, and would naturally make a small image at F, but the cone of rays, before reaching the focus, is intercepted by the double concave eye-piece C, and thence conveyed to the eye in erect position. Fig. 6 shows the Porro Prism instrument, the most modern and efficient form of terrestrial telescope. The objective and the lenses are in the same relation to each other as was first illustrated in the astronomical telescope, Fig. 1. Two double-reflecting, 90-degree prisms are inserted within the cone of rays between the eye-piece and the objective (Fig. 6); their mission being to erect the image which, in the ordinary refracting telescope, is shown inverted. This system was the invention of the Italian engineer, Porro, who patented it in France about 1850.

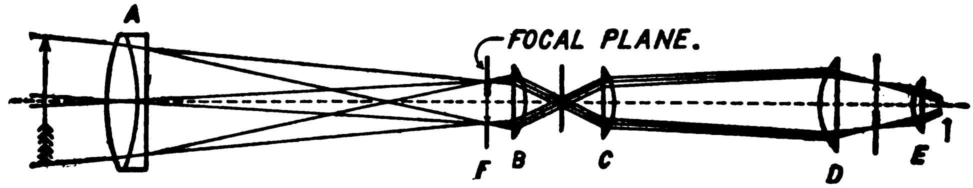


FIG. 4. — Terrestrial Telescope (spy glass).

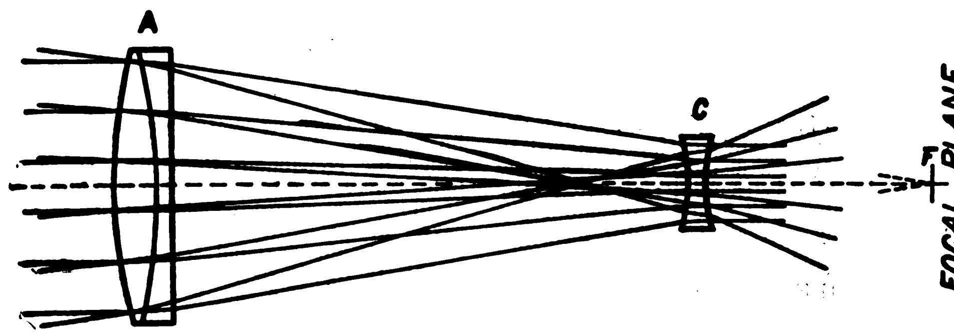
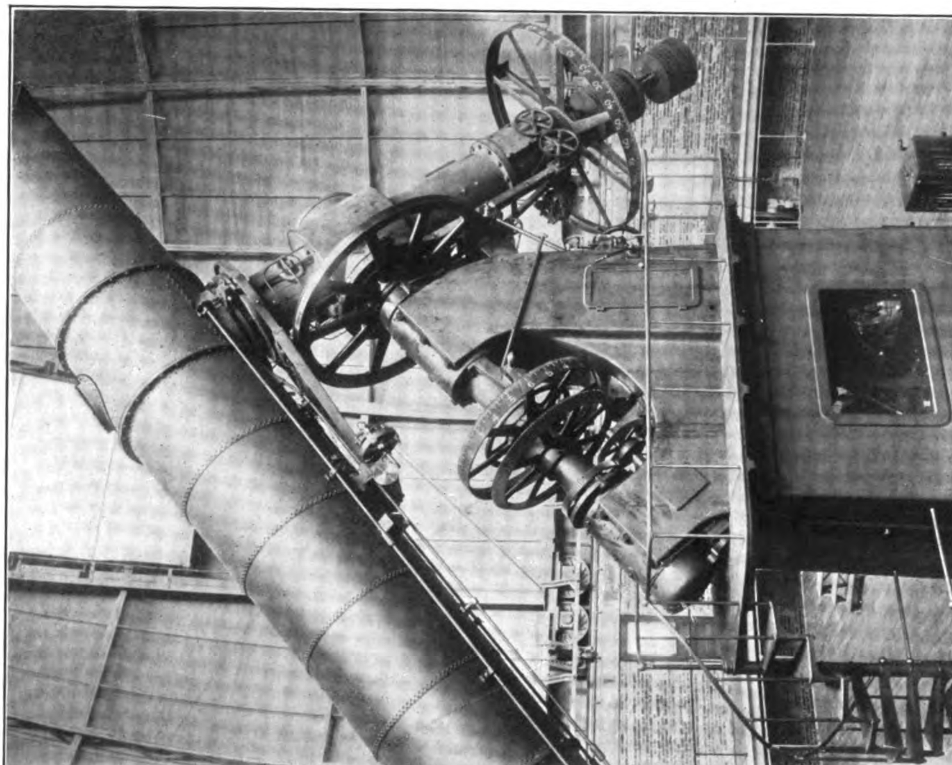


FIG. 5. — Galilean Telescope (opera glass).

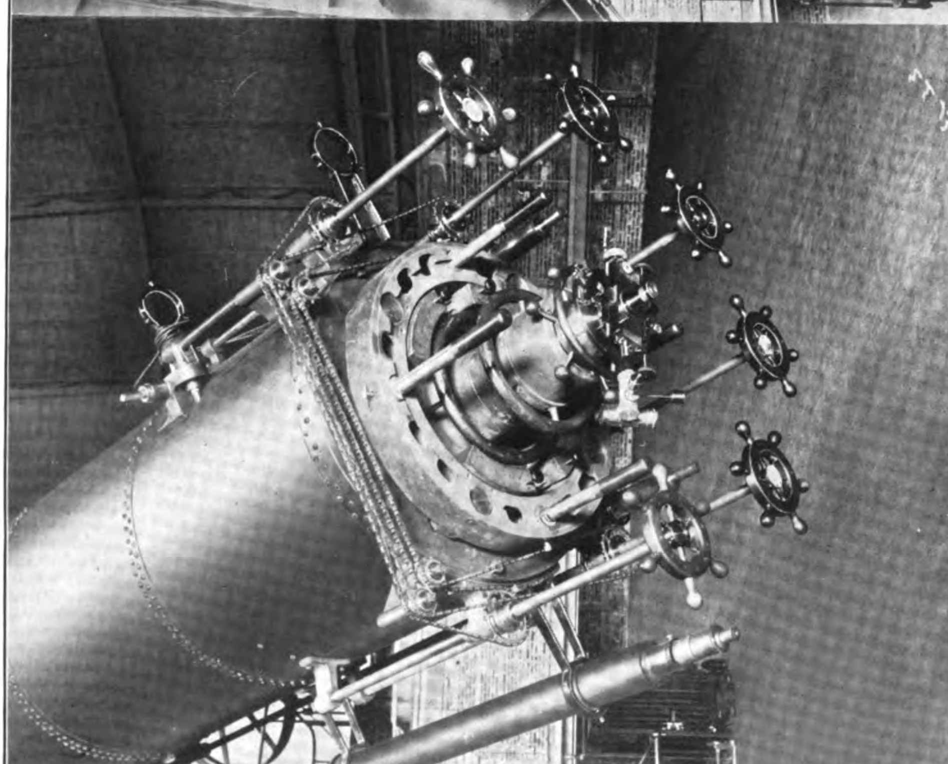
The magnifying power of telescopes is usually expressed in diameters and is indicated by the ratio of the focal length of the objective to that of the combination of lenses forming the eye-piece. For example, the Lick telescope has a focal length of 56 feet or 672 inches. If, therefore, an eye-piece of one inch focus is used in this telescope, the power resulting will be 672 diameters, and eye-pieces of longer or shorter focus will give correspondingly lower or higher powers. The practical limit of power in telescopes of the highest degree of accuracy is usually considered to be about 100 diameters per inch of aperture. Thus the 36-inch Lick telescope may be practically used with an eye-piece which would give a power of 3,600 diameters. Such high powers are, however, seldom required and can be used only in the clearest atmosphere. By far the larger proportion of astronomical observations are made with powers of less than 1,000 diameters. In telescope observations, the two elements "power" and "light," while equally important, are always in opposition. Thus an object viewed with a power of 100 diameters is four times as brilliantly illuminated as would be the case if an eye-piece giving 200 diameters were used. It follows, therefore, that the observer will use the power best adapted to his purpose, both as to magnification and light.

The telescope giving the minimum power is the opera glass, usually magnifying two and one-half or three diameters, which is sufficient for indoor use, while for outdoor use the Galilean binocular has a power of four or five diameters, and the prism binocular of six, eight, 10 or even 12 diameters. The eight-power is, however, considered as high as can be held in the hands with sufficient steadiness to give the best results. The power used in terrestrial telescopes steadily mounted on a tripod usually ranges from 15 to 100 diameters, depending on the condition of the atmosphere.

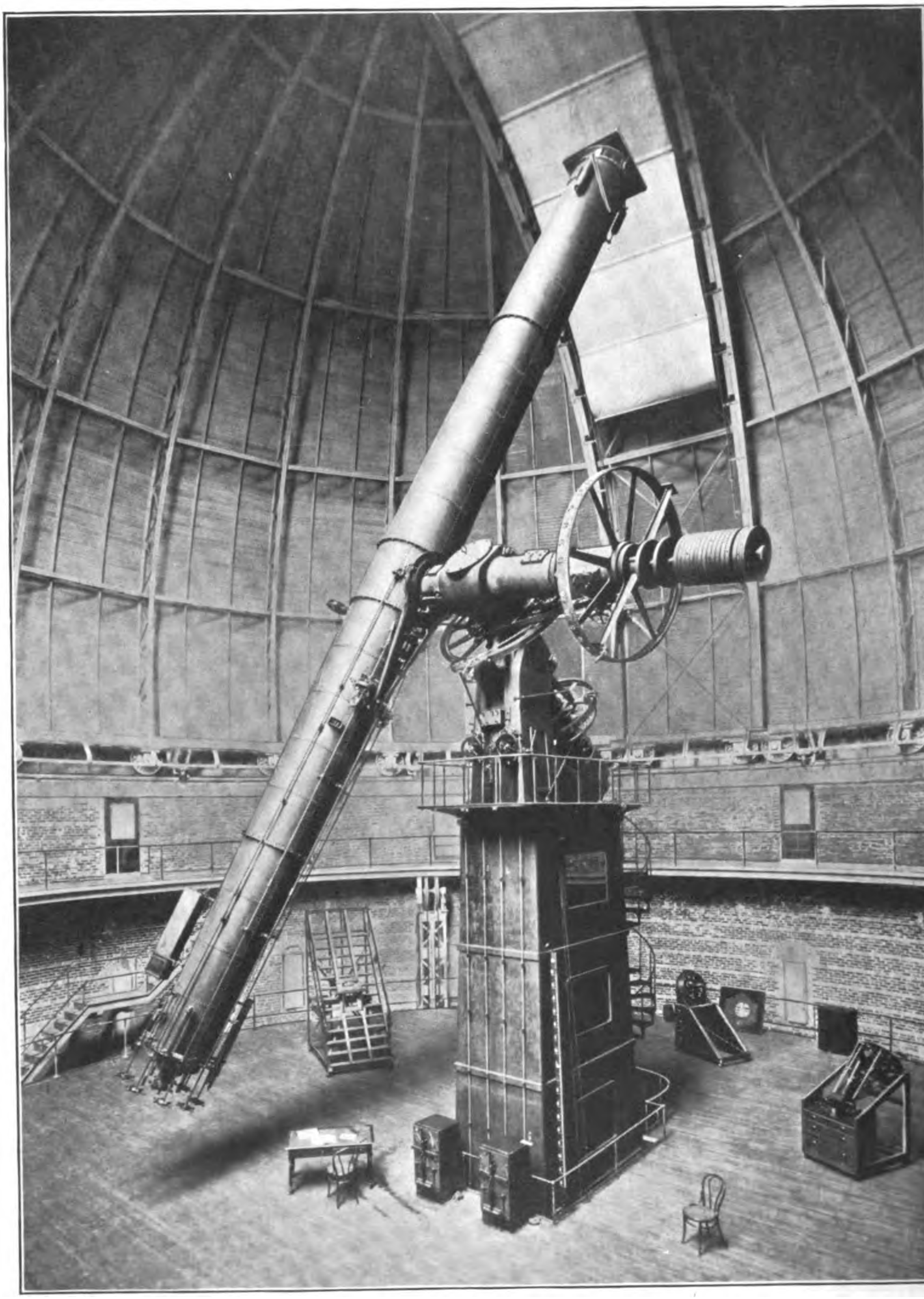
The most important element in a refracting telescope is the objective, and, in a reflecting telescope, the mirror or speculum. The objective of the early refracting telescope was a double-convex lens, which could not give a distinct image because it separated each ray of light into its various prismatic colors, and each color, having a refracting power different from



Mounting of Yerkes Telescope



Eye End of Yerkes Telescope



Yerkes Telescope

the others, found a focus of its own. The red ray, being most refracted, reached its focus first; next came the yellow ray, then the green and last and nearest of all to the eye-piece, the blue ray made its image. When a star is viewed with such a telescope the image seen consists of a yellowish point at the centre, surrounded by a mixture of green and blue light, with red outside. This difficulty in refracting telescopes, called chromatic aberration, checked the progress of astronomy for 150 years, until, in 1750, the English optician, Dolland, invented the achromatic objective as shown in Fig. 1. In this diagram E is a double-convex lens of crown glass and D a flint-glass lens of nearly plano-concave form. The difference between the crown and flint material in light refraction and dispersion, together with the compensating form of the two lenses, results in clear and distinct "definition," the image of the star being sharply outlined and colorless. Optical glass for such lenses is of special manufacture. The world's supply comes from three makers, one each in England, France and Germany. The newer objectives are made of several thin lenses cemented together, usually four in number and alternately crown and flint glass. Some makers are using five lenses successfully, though which much difficulty. The mirror or

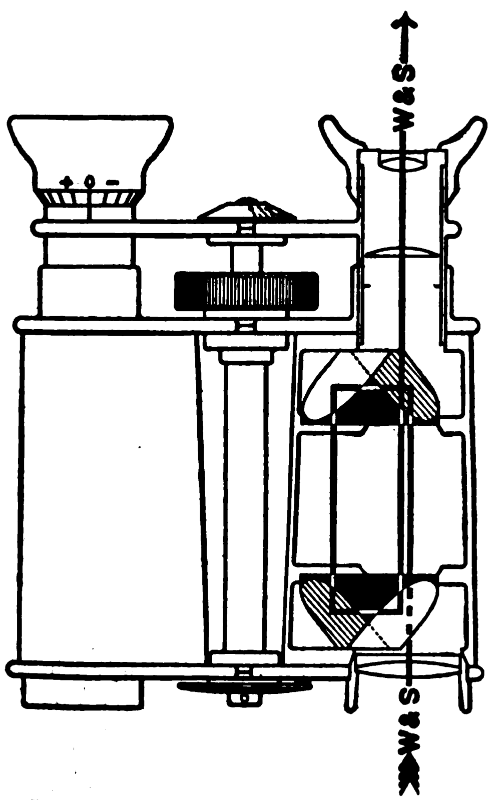


FIG. 6.—Universal Prism Field Glass (sectional view).

speculum of the reflecting telescope is made from a casting of ordinary glass of sufficient thickness to be handled without flexure, preferably one-sixth of the diameter of the disc, although one-eighth is a commonly accepted proportion in the case of very large discs. The reflecting surface is ground and polished, with great precision, to a parabolic form of the focus required, and then, by a chemical process, coated with silver, which may be easily renewed when tarnished or otherwise injured.

The making of the optical parts of telescopes is a rare art, which, however, has been cultivated with peculiar success in America. Alvan Clark and Sons of Cambridge, Mass., attained world-wide fame in this connection during the lifetime of the gifted men composing the firm. At the present time the largest reputation as a maker of large telescopic objectives belongs to John A. Brashear of Pittsburgh, Pa.

The telescope tube is usually carried by an equatorial mounting. This form of instrument has its principal or polar axis set parallel to the axis of the earth, its inclination, therefore, corresponding to the latitude of the observatory. At right angles to the polar axis is the declination axis, which, in turn, carries the telescope tube at right angles to itself. Each axis is supplied with a graduated circle, indicating, respectively, the position of the star in hours, minutes and seconds of right ascension, and in degrees, minutes and seconds of declination. It will be evident that when the tube is pointed to a star in any part of the visible heavens, a revolution of the polar axis from east to west, in sidereal time, will make the telescope follow the apparent motion of the star. A driving clock, which is usually located inside the column of the instrument, controls the revolutions of the polar axis so that the star observed remains steadily in the field of vision. The equatorial principle has been applied to photographic telescopes in such manner as to allow the continuous exposure of the photographic plate during the entire night, if desired. One of the most ingenious forms of mounting is the Equatorial Coudé. In this instrument the polar axis is enlarged so as to serve as the main tube of the telescope, the eye-piece being at the upper end where the observer can sit comfortably in his warm room and observe any star in the visible heavens as easily as he uses his microscope.

An elbow is rigidly attached to the lower end of the tube. At the intersection is an accurately polished mirror set at an angle of 45 degrees. At the outer end of the elbow is another mirror, similarly set. The objective is so placed that the light it gathers from the star is reflected by the mirrors through the tube to the eye-piece. The combined movements of the polar axis (the telescope tube) and the objective and mirror carried on the elbow enable the observer to bring into view any star in the visible heavens. The polar axis, with its elbow carrying the objective and revolving in sidereal time by means of a driving clock, follows the apparent motion of the star in the usual way. Two of these instruments are in successful use in the Paris Observatory.

It will be evident that the equatorial telescope with its various modifications as above described, while giving facilities for examining and photographing the heavenly bodies, does not enable the astronomer to determine with required accuracy the positions of the stars and planets. These fine measurements are secured only by special forms of telescopes. The Meridian Circle is one of the most approved instruments for this purpose. From the middle of the tube trunnions extend on either side, carrying finely graduated circles and terminating in accurately ground pivots which are exactly at right angles to the optical axis of the tube. Two piers are so set as to form a rigid and accurate support for these pivots, east and west, carrying the tube so that the movement of the telescope is in the true meridian only. In the exact focus of the telescope a fixed system of cross-hairs or wires is placed. The best materials for this purpose are taken from the cocoon of the field spider, the web being only one five-thousandths of an inch in diameter. Finely drawn platinum wires are also used. These vertical spider webs are equally spaced and so adjusted that the central wire is exactly in the optical axis of the telescope as measured east and west. A horizontal wire is adjusted exactly in the optical axis as measured north and south. Parallel to these central wires there are two movable wires, one horizontal and one vertical, each governed by a micrometer screw.

In measuring transits of stars for determining right ascension, or for time, the telescope, by means of the graduated circles, is set to the declination of the star required, and when the star appears, its transit across each of the wires is recorded on a chronograph, by the observer tapping an electric key. In determining declinations, the telescope, by means of the graduated circles, is set to the approximate declination of the star to be observed, and when the star appears at the edge of the field, the observer carefully adjusts the telescope until the star seems to be exactly bisected by the horizontal wire as it threads its way across the field. By reading the fine circle the declination of the star is obtained. Other types of telescopes for similar observations are known as transits, zenith telescopes, mural circles, etc., but the illustrations given will suffice.

Even with all the caution used in the construction of these delicate instruments, errors are sure to develop, due to refraction, flexure of the tube, variation resulting from changes in temperature and other contributing causes, for all of which allowance must be made in the final reduction of the observations. About the middle of the last century Professor Airy, then Astronomer Royal at Greenwich, designed and constructed a vertical telescope, which he believed would eliminate the errors so manifest in his other instruments. He named it the «Reflex Zenith Tube.» The principle is shown in Fig. 7. Every part of the instrument is stationary and no part need be touched when in use by the astronomer. The light from the star as it passes the zenith is concentrated by the objective upon a surface of mercury in the base of the column, by which it is reflected back through a hole in the objective; the cone of rays then meets a diagonal prism, is reflected at right angles and enters the eye-piece to be observed as in other instruments. Contrary to the expectations of the Astronomer Royal, errors in the observed position of the stars were still manifest and the most careful investigations failed to trace them to their source. The instrument was, therefore, discarded. Fifty years later, Professor Chandler, of Cambridge, Mass., discovered that the pole of the earth «wobbles» slightly, causing a variation in latitude. The results of his observations were compared with the Airy observations of a half century before, and the supposed errors of the «Reflex Zenith

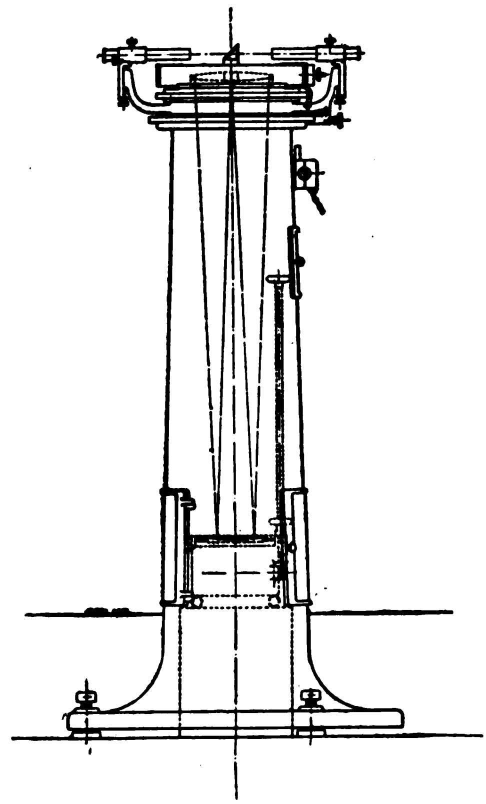


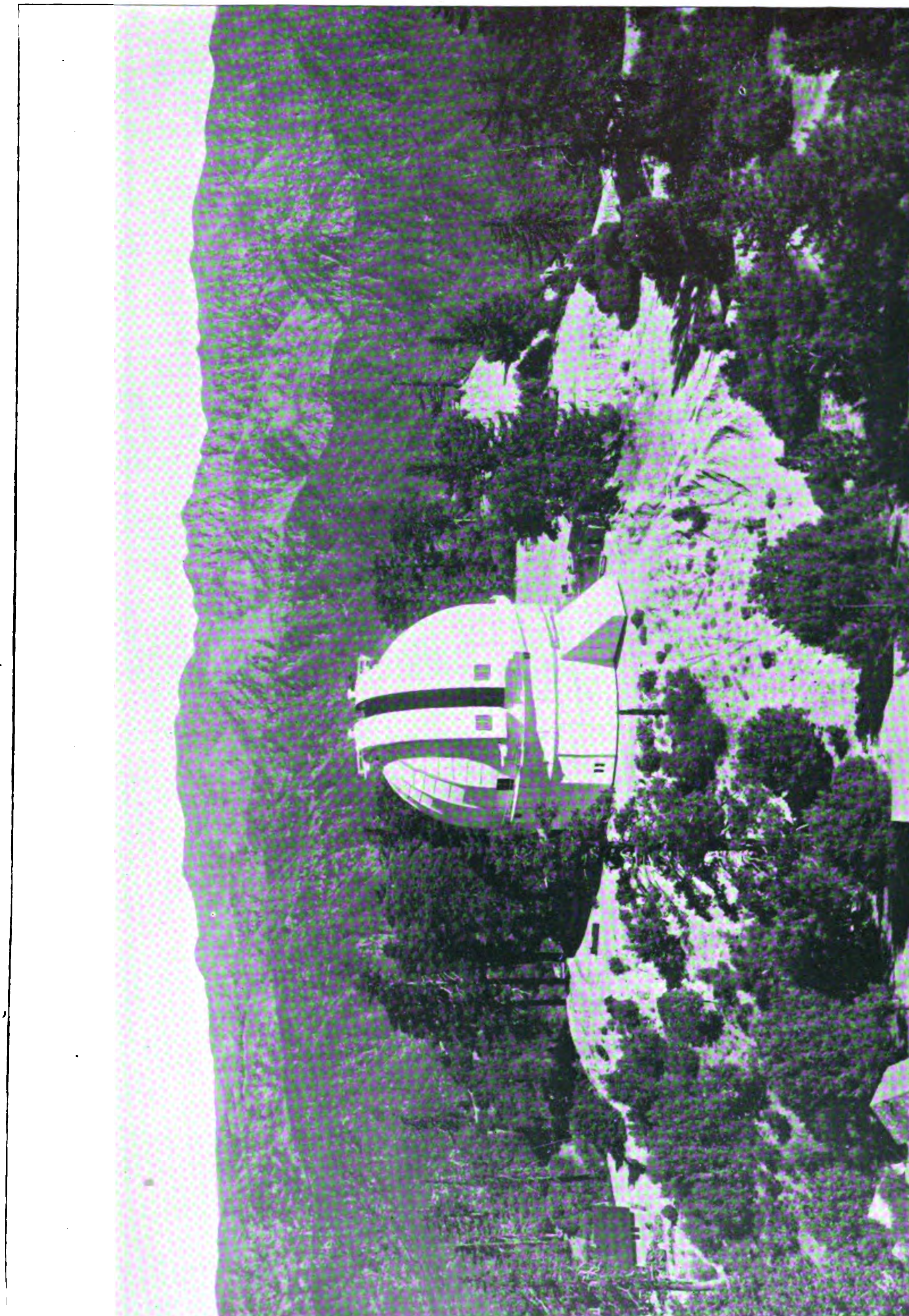
FIG. 7.—Reflex Zenith Telescope.

Tube» were at once traced to the variation in latitude. The old instrument which had been condemned is thus proven to be correct both in theory and practice. It, therefore, represents the latest development in astronomical telescopes, and a large Reflex Zenith Tube is now in the service of the University of Pennsylvania.

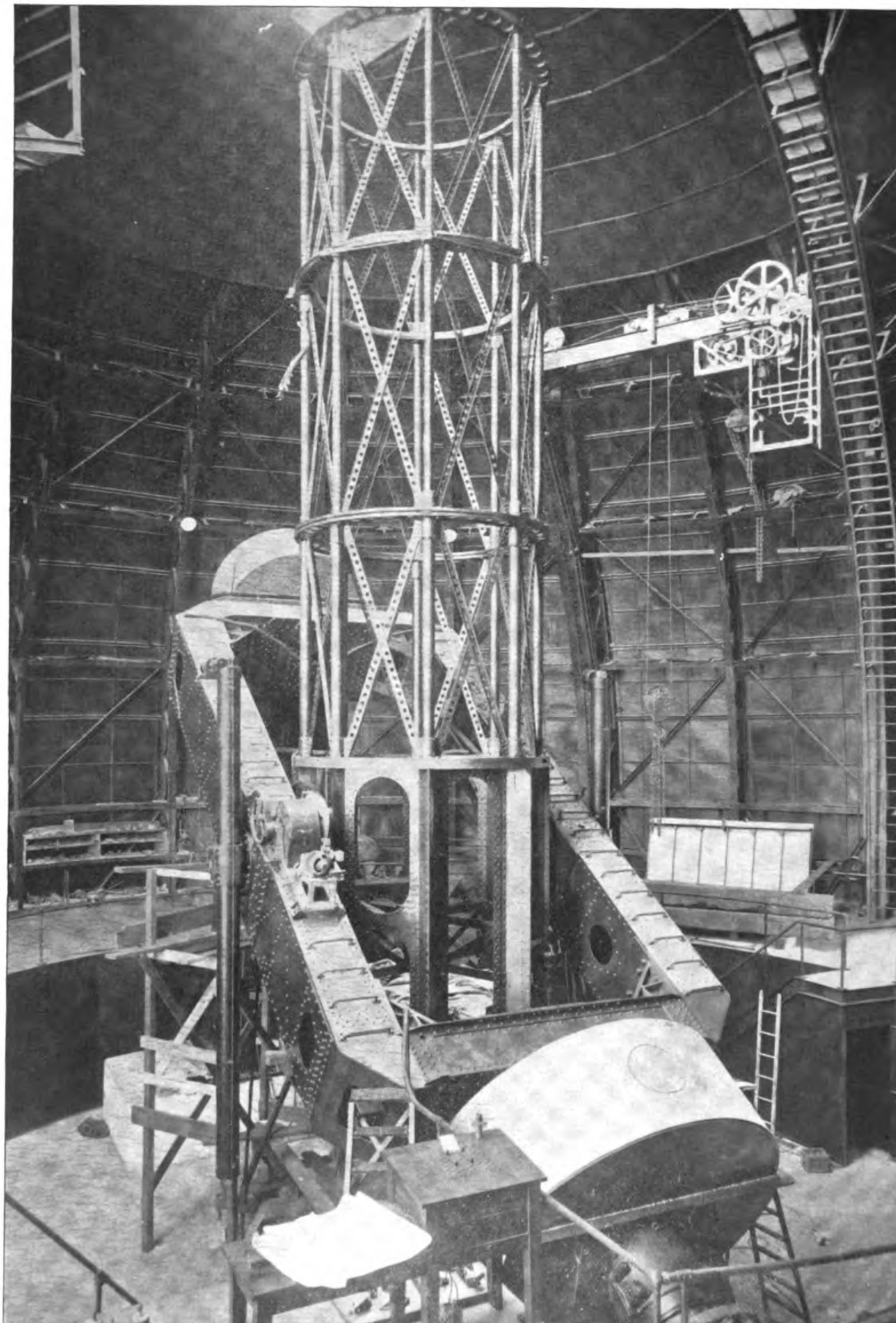
In recent years the mounting of great equatorials has passed from the domain of the instrument-maker to that of the engineer, who finds abundant scope for ingenuity and technical expertness in combining very massive and so, rigid, construction with very delicate mechanism. At the present time the largest telescopes in the world are owned and made in America.

The table on following page gives a list of the larger refracting telescopes in the equipment of the more important American observatories.

While the refracting telescope still holds its advantages for photographic astronomical work the tendency of late years has reverted to the reflecting telescope for visual work. Astronomers prefer it because of the much clearer images obtained, due in large part to the entire absence of the secondary spectrum. The images formed by the best refractors have a turbid quality as compared with the clean crispness of the reflector. As in the case of the refracting instruments, America boasts the largest reflectors. The largest of all is the



The 100-foot Dome, Mount Wilson Solar Observatory, Pasadena, Calif.



The 100-inch Hooker Telescope, Mount Wilson Observatory, Pasadena, Calif.

NAME OF OBSERVATORY	Aperature of telescope	Maker of objective	Maker of mounting
	Inches		
Yerkes (University of Chicago)	40	Alvan Clark and Sons	Warner and Swasey
Lick (University of California)	36	Alvan Clark and Sons	Warner and Swasey
United States Naval	26	Alvan Clark and Sons	Warner and Swasey
University of Virginia	26	Alvan Clark and Sons	Warner and Swasey
Lowell (Harvard University)	24	Alvan Clark and Sons	Alvan Clark and Sons
Princeton	23	Alvan Clark and Sons	Alvan Clark and Sons
University of Pennsylvania	20	John A. Brashear	Warner and Swasey
Northwestern University	18½	Alvan Clark and Sons	Alvan Clark and Sons
Carleton College	16	John A. Brashear	Warner and Swasey
Mount Wilson Observatory	100⅜	....	....

Hooker reflecting telescope of the Mount Wilson Observatory, Pasadena, Cal., with a clear aperture of 100⅜ inches (2.549 meters) and a primary focal length of 507.5 inches (12.891 meters); it can be used directly on the axis either (a) as a focal plane instrument, or (b) in the Newtonian form; at its secondary foci it may be used (c) as a Cassegrain instrument with a focal length of 1,606 inches (40,792 meters), or (d) as a Coudé with focal length of 3,011 inches (76.480 meters). Celestial objects from 65° north to 53° south declination can be observed at the principal focus. The telescope is mounted after the English fashion, the skeleton tube containing the mirror at its lower end swinging between the sides of the open polar axis yoke which has a bearing at either end resting on cast-iron pedestals built up from the main concrete pier below. The mounting was designed by Mr. Pease and other members of the observatory staff, assisted by Prof. Peter Schwamb of the Massachusetts Institute of Technology. The pier is 33 feet high while the intersection of the axes is 50 feet above ground. Both the declination and right ascension bearings are composite; in part, of spherical type, serving to define the axes, while the remainder carries the load. The declination load is carried by means of counterweight systems while the polar axis is supported by means of steel drums built integral with the axis and floating in cast-iron tanks filled with mercury. The tube complete weighs 35 tons and the total moving parts weigh 100 tons. They are constructed of cast and structural steel throughout and in as large units as could be machined as a whole. The larger portions of the mounting, some weighing 10 tons, were made in Quincy, Mass., and their transportation up Mount Wilson to an elevation of 5,700 feet was a difficult feature in the erection of this instrument. The mirror is 101.2 inches diameter, 12¾ inches thick and weighs about 9,000 pounds. It was cast in Saint Gobain, France, and figured by G. W. Ritchey in the observatory optical shops. It is mounted on a counterweight support system in the rear and on four edge arcs at the sides. To control its temperature it is surrounded with a lining of cork board built integral with its cell, and a system of piping is installed within this through which liquid at any desired temperature may be circulated from tanks in the pier below. Fans serve to equalize the temperature around mirror and coils. When it becomes necessary to resilver the mirror it is removed from the tube and lowered in its cell by an electric elevator into the pier, where all apparatus and material is at hand and where the temperature may be controlled. The telescope has motor-driven fast and slow motions, while the diurnal motion is supplied by the typical form of driving clock having a conical pendulum isochronously governing a falling weight. This operates through a worm and a worm wheel (17 feet in diameter) cut and ground with high precision. The instrument is controlled, settings are made and the dome is turned from a station on the pier at which the readings of the circles are made; the "remote" system of electrical control is used throughout, and most of the operations are duplicated by auxiliary controls at the three observing stations or foci. To reach the principal focus an observing platform is provided which travels along the shutter opening. The dome is of structural steel throughout, 100 feet in diameter, 100 feet high and weighs 730 tons. The rotating portion weighing 500 tons is carried on 28 trucks and is traction, driven by two motors at opposite sides. The trucks and rails are carefully machined to conical surfaces to eliminate vibration at the telescope when the dome is moved. The shutter is in halves which open sideways and permit free working of the telescope from the zenith to the horizon. The walls and dome are of double construction and are ventilated at the top to prevent excess heating during the summer. A 10-ton crane is provided to assist in the erection and in the transfer of the various auxiliary sections of the tube.

The second largest reflector in the world is the 72-inch instrument set up in 1918 on Little Saanich Mountain on Vancouver Island, British Columbia, in the Dominion Observatory there. The mirror of this instrument was ground by the John A. Brashear Company of Pittsburgh, from a disc of glass cast in Belgium and shipped out of that country two days before the war broke out. The mirror is parabolic, 13 inches thick at the rim with a hole 10⅛ inches in diameter through its centre. It weighs 4,340 pounds and has a focal length of 30 feet. Observations may be made from the side of the upper part of the tube, from the side at the lower end or through the opening at the centre of the mirror. The telescope with all its fittings weighs 55 tons and is moved by an amount of electric current barely sufficient to light a 16-candle power electric lamp. The mounting was built by Warner and Swazey. The only other telescope of this size in existence is that of Lord Rosse set up upon his estate in Ireland in 1842. Its first mirror was of speculum metal and was replaced by a 72-inch silvered glass mirror in after years. For a long period it was the largest telescope in the world; but was abandoned for optical reasons.

There are three 60-inch reflectors in the Western Hemisphere, the newest one erected at the National Observatory of the Argentine Republic near Cordoba. The mirror was made by the John A. Brashear Company in 1916. In 1904 Harvard University secured the 60-inch reflector made by Dr. A. A. Common of Ealing, England. This instrument is of the Cassegrainian type and has a rectangular tube. The mounting is peculiar, the telescope being supported in position upon the end of a hollow cylinder which floats in a well or deep basin of water. The cylindrical float is 18 feet long and seven and two-thirds feet in diameter and arranged to float constantly at an angle with the horizon equal to the elevation of the celestial pole at Cambridge—about 45 degrees. The instrument weighs over 20 tons, but is so delicately balanced that it may be moved in any direction with the greatest ease by its electrical controls. The eye-piece of the instrument is detached from the telescope and housed in the second story of an adjacent building, the light from the principal mirror being directed to it by accessory mirrors.

The 60-inch reflector of the Mount Wilson Observatory, constructed by Dr. Ritchey in 1908, was placed in commission in December of that year. The instrument complete weighs 21½ tons, nearly all of which is ingeniously supported upon a float in a basin of mercury, of which it displaces the equivalent of 50 cubic feet, although the entire amount of mercury in the basin is but 635 pounds. The controls are electric and may be manipulated from several stations about the instrument.

Another fine telescope which should be mentioned in this connection is the 48-inch reflector built by Sir Howard Grubb and located at Melbourne, Australia.

For more detailed descriptions of these wonderful instruments and their achievements the files of the astronomical journals are recommended.

WORCESTER REED WARNER, F.R.A.S.,
Of the Warner and Swasey Company, Cleveland, Ohio.

TELFORD, tĕl'fŏrd, **Thomas,** Scottish engineer: b. Eskdale, Dumfriesshire, 9 Aug. 1757; d. Westminster, 2 Sept. 1834. At 14 he was apprenticed to a mason and on the expiration of his time worked as a journeyman at that trade, but subsequently removed to Edinburgh and there applied himself to the study of architecture. In 1782 he went to London, where he was befriended by Sir William Pulteney, through whom he was appointed surveyor of the public works in Shropshire. He now became a civil engineer and in 1793 was entrusted with the construction of the Ellesmere Canal, to connect the Mersey, Dee and Severn. In 1803 and 1804 the Parliamentary commissioners for making roads and building bridges in the Highlands of Scotland, and also for making the Caledonian Canal, appointed him their engineer. Under the former board 1,200 bridges, two of 150 feet span, were built and 1,000 miles of new road were made; and under the latter board the Caledonian Canal was constructed. Under other commissioners he built over 30 harbors, some of which, as at Aberdeen and Dundee, are upon an extensive scale. He was also employed in England, superintending the construction of five large bridges over the Severn, of eight canals, and the execution of numerous important works for the metropolis. In 1808 he was employed by the Swedish government to lay out a system of inland navigation through the central parts of Sweden and to form a direct communication by water between the North Sea and the Baltic. He also built the road between Warsaw and Brest-Sitovski in Poland. The greatest monument of his engineering skill is the Menai Suspension bridge, connecting Caernarvonshire with the island of Anglesea, which was opened on 30 Jan. 1826. In 1828–30 he superintended the drainage of nearly 50,000 acres of the Fen country. He invented the Telford pavement. See ROADS, IMPROVEMENT OF.

TELHARMONIUM, an electrical instrument devised to produce music at any distance from a central station. The device was invented by Dr. Thaddeus Cahill (q.v.) and operates on the principle of the telephone, but the receiving instrument is not held to the ear. The music is produced through the medium of dynamos transmitting vibrations to any number of receiving stations. The operator plays on a keyboard similar to that of an organ, the keys controlling electric currents at varying speeds of alternation and producing the notes of practically any instrument with great purity and sweetness.

TELL, tĕl, **William,** Swiss peasant of Bürglen, near Altorf, celebrated in legend for his resistance to the tyranny of the Austrian governor, Gessler. The stories connected with him, with those relating to the origin of the Swiss Confederation, first appear in the 15th century. According to them, Gessler, the tyrannical Austrian bailiff of Uri, one of the forest cantons, pushed his insolence so far as to require the Swiss to uncover their heads before his hat (as an emblem of the Austrian sovereignty), and condemned Tell, who refused to comply with this mandate, to shoot an apple from the head of his own son. Tell was successful in his attempt, but confessed that a second arrow, which he bore about his person, was intended, in case he had failed, for the punishment of the tyrant, and was, therefore, retained prisoner. While he was crossing the Lake of the Four Cantons, or Lake of Lucerne, in the same boat with Gessler, a violent storm threatened the destruction of the skiff. Tell, as the most vigorous and skilful helmsman, was set free, and he conducted the boat successfully near the shore, but seized the opportunity to spring upon a rock, pushing off the bark. He had fortunately taken his bow with him, and when the governor finally escaped the storm, and reached a rocky defile on the road to Küssnacht, Tell shot him dead. The death of Gessler was the signal for a most obstinate war between the Swiss and Austrians, which was not brought to a close until 1499. Tell was present at the battle of Morgarten, and is supposed to have lost his life in an inundation in 1350 while attempting to save a friend. Such is the legendary story of William Tell. Investigation has broken down the proofs of his existence. There is no mention of him by any contemporaneous historian; his name is first met with in the chronicles of the second half of the 15th century, and none of the Tell ballads are of an earlier date. Similar stories in regard to the shooting of the apple occur in Saxo Grammaticus, the Danish historian, and in Icelandic literature, not to mention the old English ballad of Adam Bel, Clym of the Cloughe and Wyllyam of Cloudeslè. Besides, the many contradictions between the various personages, dates and places, and the widely differing representations of the event, show the gradual development of the legend. The untiring industry of historical scholars has not been rewarded by the finding of the name of Tell in the archives and church registers of Uri, and although an uninterrupted series of charters exists relative to the bailiffs or governors of Küssnacht in the 14th century, there is no Gessler among them. The Tell chapels were erected or called by his name generations after his death; the document which speaks of the assemblage in 1388 of 114 persons who knew him personally, and of the erection at that time of a Tell chapel on the shore of the Lake of Lucerne, was not known until 1759. Consult Hisely's 'Recherches Critiques' (1843); Rochholz's 'Tell und Gessler in Sage und Geschichte' (1877); Gisler's 'Die Tellfrage: Versuch ihrer Geschichte und Lösung' (1895). See SWITZERLAND, *History*.

TELL CITY, Ind., city in Perry County, on the Ohio River, 125 miles southwest of Indianapolis, on the Southern Railroad. There are deposits of coal and clay in the vicinity, and manufactures include furniture, iron products, woolens, flour and tobacco. The city was founded by the Swiss Colonization Society in 1857. Pop. 3,369.

TELL EL AMARNA, Egypt, a district near the east bank of the Nile, 190 miles above Cairo, comprising the site and environs of the ancient city of Akhenaton, known also as Ekhaton and Akhet-Aton, built by Amenophis IV, who later was known as Akhenaton or Ikhnaton. The city was built by Amenophis about 1360 B.C. as a new capital of the empire in place of Thebes after he had abandoned the religion of Ammon for that of Aton. It grew rapidly but was abandoned upon the death of Amenophis, the court returning to Thebes as its capital and to the worship of Ammon. The most important ruins are those of the palace and the House of Rolls, and there are remains of the temple. About 300 clay tablets containing valuable records of the time of Amenophis and his father were discovered in the House of Rolls in 1887. To the northeast and to the south of the ruined city are tombs hewn in the sides of the hills which abound in sculptured scenes picturing mainly the worship of the sungod. The tomb of Meri-Ra, high priest of the sun, has two spacious chambers and a façade nearly 100 feet long. The tomb supposed to be that of Amenophis is in a ravine about midway between the north and the south tombs. Consult Petrie, F., 'Tell el-Amarna' (1894); Davies, N. de G., 'Rock Tombs of Tell el Amarna' (1903–08); Petrie, W. M. F., 'Syria and Egypt from the Tell el Amarna Letters' (1898).

TELL EL KEBIR, Egypt, village in the northeastern portion of the country, on the Sweetwater Canal, 18 miles southeast of Zagazig. It was the scene 13 Sept. 1882 of a battle between the English forces commanded by Sir Garnet (later Lord) Wolseley and the Egyptians under Arabi Pasha, which resulted in the utter defeat of the Egyptians.

TELLER, tĕl'ėr, **Henry Moore,** American senator: b. Granger, Allegany County, N. Y., 23 May 1830; d. Denver, Colo., 23 Feb. 1914. He was educated at Alfred University, New York, taught school, and after admission to the bar practised law in Illinois and Colorado. He was United States senator from Colorado 1876–82, Secretary of the Interior 1882–85, and was a member of the national Senate from 1885, except for a brief interval 1896–97, up to 1909. He was especially prominent as a silver advocate, and had the unusual experience of serving his constituents as a nominee of the Republican and later of the Democratic party.

TÉLLEZ, tĕl'yăth, **Gabriel,** Spanish dramatic author, better known by his pseudonym, EL MAESTRO TIRSO DE MOLINA: b. Madrid, between 1570 and 1572; d. Soria, 12 March 1648. He studied at Alcala and remained for some time at Toledo, whence some of his works are dated, also in Galicia and in Seville. The date of his profession as a Brother of Charity is unknown, but we know that he had become superior by 1619. In 1634 he was named *Definidor general* of Castille. His first poetical work, 'Los Cigarrales de Toledo' (1624) is a collection of tales in which there is a semblance of the influence of Boccaccio. This influence is clearer in 'Los tres maridos burlados,' which is an admirable adaptation of the 'Decameron.' Instead of a second part of the 'Cigarrales' promised by the author there appeared in 1635 a new collection ('Deleitar aprovechando') of religious stories mixed with 'Autos,' of which 'El Colmenero divino' is one of the best efforts in religious drama. For a long time Téllez devoted himself to this species of composition. In 1620 he dedicated to his friend Lope de Vega 'La Villana de Vallecas' and four years later he stated that he had written well nigh 300 comedies. He excelled in the religio-theological dramas of his period and also in historic dramas, farces and *comédies d'intrigue*. He had a penchant for epigram but was capable of reaching the highest conceptions and frequently sounded tragic depths. Some of his works are equal to Calderon's or Lope's best and in recent years critics have begun to do him full justice. An eloquent proof of his merit is that some of his works have been attributed for centuries to Lope or to Calderon. Such was the case of 'El Burlador de Sevilla y Convidado de Piedra,' an admirable scenic portrayal of the legend of Don Juan, which, although universal as proved by Farinelli, has taken on the character of a purely Spanish legend through this work of Téllez, which has been widely imitated in other literatures. It is his best work and in order of importance may be mentioned 'La prudencia en la mujer'; 'Marta la piadosa'; 'El vergonzoso en Palacio'; 'Don Gil de las calzas verdes'; 'El amor y la amistad,' and 'La villana de Vallecas.' It has been said that his feminine characters are lacking in amiable traits. He was to a great extent free from the stylistic vices of his period and was often imitated by Calderon. It is difficult to comprehend the obscurity into which his works and reputation fell soon after his demise. To-day we possess about 80 of the 400 pieces we know came from his hand. He also wrote historical works including 'La Genealogia del Conde de Sástago' (1640); 'La Cronica' of the Brothers of Charity. (See EL BURLADOR DE SEVILLA). The best editions of his works are those of Augustin Durán, of Hartzenbusch, 'Teatro escogido de Tirso de Molina' (12 vols., 1831–41); by Romanos (1848); and Rivadeneira 'Comedias escogidas de fray Gabriel Téllez.' Consult Cotarelo, C., 'Tirso de Molina: Investigaciónes bio-bibliográficas' (Madrid 1883); Morel-Fatio, A., 'Etudes sur le théatre de Tirso de Molina' (in *Bulletin hispanique* 1900); 'Nueva biblioteca de autores españoles' (Madrid 1906–07); Armesto, 'La leyenda de Don Juan' (ib. 1908).

TELLICHERRY, tĕl-ĭ-chĕr'ĭ, or **TELLICHERRI,** India, a seaport and garrison town in the Malabar district of Madras, 45 miles northwest of Calicut. The main buildings include the castle — now a jail — the North Malabar district court, custom-house, churches and government offices. The entire area, on a picturesque site, covers about five square miles. The principal exports are sandal wood, coffee and cardamons, spices, cocoa and cocoanuts. The factory of the East India Company was founded in 1683. There are missions and other schools; also Brennan College founded in 1862. Pop. 27,883.

TELLURIUM, an element discovered by Mueller von Reichenstein (1782) in a specimen of gold ore from Austria. Klaproth named it from the Latin *tellus,* meaning the earth. Tellurium occurs free, but most commonly in company with gold, silver, lead and bismuth. Native tellurium is found in considerable quantity in Boulder County, Colo. The other important minerals containing tellurium are sylvanite, calaverite, pelzite, hessite and tetradymite. They are found principally in Austria, and in the United States in Colorado and adjacent States.

Tellurium is a silver white metal, atomic weight 127.6, melting point about 453° C. and specific gravity 6.25. It is brittle, not changed by exposure to the air and when heated a little above its melting point it boils and condenses again in the cool portion of the retort as metallic drops. In chemical properties it is very like sulphur. It unites with chlorine readily, forming $TeCl_2$ and $TeCl_4$. The oxides TeO_2 and TeO_3 are analogous, yet differ considerably from SO_2 and SO_3. Tellurious and telluric acids and the salts derived from them are also known. Tellurium forms a compound with hydrogen analogous to H_2S and possessing an even more disagreeable odor.

This element resembles sulphur in imparting very undesirable properties to metals even when present in very small amount. If tellurium and any of its compounds are introduced into the human system they give the breath a very strong and disagreeable garlic-like odor. To obtain the free element the ore is digested first with sulphuric acid; hydrochloric acid is then added in small quantity and the whole treated with sulphurous acid which precipitates the tellurium.

TELPHERAGE, aerial transportation, as in a cable or elevated railway, by electric power, arranged for automatic operation. Both the system and the word «telpherage,» which means «distance carrying,» were introduced by the late Fleeming Jenkin. He recognized the ease with which the electric motor could be adapted to automatic transportation of materials and he devised a system which when put into service gave satisfaction. This consisted of two overhead cables, mounted on stout poles, along which light carriers were hauled by means of one or more electric motors. To transmit current to the motors the cables were cut into sections, adjacent sections of one cable being insulated from each other, but cross-converted with sections of the other cable so as to form two continuous conductors, each lying alternately on the right and on the left of the system. The trains were somewhat longer than the sections of cable so that one end rested on one conductor while the other was on the second, thus completing the electric circuit.

Modern telpherage systems are more elaborate than Jenkins'. As usually constructed, a light steel framework supports a system of light elevated rails, from which buckets or carriers are suspended, hanging on wheels on the rail or rails. Small electric motors are placed on the carriers. The current is transmitted to the motors by means of a small trolley wire erected over the running cable or rail. Sometimes a double trolley system is adopted. The telpher or towing vehicle is usually equipped with two motors. These may be placed on opposite sides of the cable or side by side. The driving wheels are mounted directly on the motor shafts, as gearings are not used. The carrier way is attached to the telpher or to a trailer and is often fitted with a third motor for hoisting the load. When heavy loads are to be carried two supports may be used, each having one or more running wheels. When the system is not automatic it is controlled from one station or an operator is carried with the train. Where the weights to be transported are light, wire cable is employed, and often the cable is supported between the posts by a suspension cable. In any case a rail is used instead of a cable when a corner is to be turned and in running through buildings where the cable construction would be difficult, or where the weight and traffic is sufficient to warrant the cost.

The advantages claimed for the telpherage system are economy in cost of transporting and a capacity for moving large quantities of material with a low cost of construction as compared with a railway. Further, the system may be erected overhead and out of the way. Telpherage systems are now used in industrial works of all kinds for carrying materials in a building as well as outside. The system may also be adapted to other work, such as excavating trenches, canal construction, etc. Consult Clark, Chas. M., 'Telpherage'; 'Transactions American Institute Electrical Engineers' (Vol. XIX, p. 391).

TELUGU, tĕl'oo-goo, or **TELINGA,** a language of India, belonging to the Dravidian group, and spoken by about 20,000,000 of people in Madras, Hyderabad, Mysore, Bombay, Central Provinces, Burma, Berar and other parts. The Telugu are the most numerous branch of the Dravidian race, but are less enterprising than the Tamils, who occupy the country to the south of them. The language is allied in roots to the Tamil language, but differs considerably otherwise. See INDIA; TAMIL.

TEMBULAND, tĕm'boo-lănd, South Africa, a district or dependency of the Cape Colony, in the east of which it is situated, on the Indian Ocean, one of the Transkei districts, adjoining Pondoland and Griqualand East; chief town Umtata. Pop. 232,000 (5,179 Europeans).

TEMENOS, anciently a sacred plot of ground; a piece of land marked off and consecrated to God. Any tract of land allotted to a temple or sanctuary.

TEMESVAR, tĕm'ĕsh-văr, Hungary, on the Bega Canal, 75 miles northeast of Belgrade. It comprises a citadel and suburbs — four in number. Noteworthy are the castle, cathedral, synagogue, bishop's residence and town-house. The manufactures include woolen goods, oil, paper, tobacco, leather, etc., and there are grain-mills, distilleries, etc. The fortress has sustained many sieges; memorable is that of 1849, when it was invested and bombarded by the insurgents. Pop. about 72,500.

TEMPE, tĕm'pē, **Vale of**, Greece, in Thessaly, a beautiful valley on the Peneus, flanked by Olympus at the north and Mount Ossa at the south. It has been immortalized by the classical poets.

TEMPERA. See DISTEMPER; MURAL PAINTING; PAINTING, TECHNIQUE OF.

TEMPERAMENT, *in music*, the system or principle of tuning voices or instruments in accord with the rule of fixed tones, universally adopted since the middle of the 19th century and first advocated by J. Sebastian Bach (q.v.) early in the 18th century. In the system of equal or even temperament, the standard interval is the mean semitone, that is the 12th part of an octave. This neutralizes the «wolf» or harsh discords of uneven temperament which otherwise exist, among all the tones of voice or instrument, so that the only exactly true intervals become octaves and the number of key scales 12, the relative pitch of the tones of the ideal scale being fixed with mathematical precision. The voice or instrument using the intervals of such a scale is said to be modulated or tuned in pure or just temperament. No further adjustment is required if these tones only are used. Modulation into another key, however, requires that some other tone than the original one shall be the keynote and one or more passing notes are necessary to arrive at the key desired (see MODULATION. For the superseded system of tuning see MEANTONE or MESOTONE TEMPERAMENT; MODE; also WELL-TEMPERED CLAVIER). Consult Groves, 'Dictionary of Music and Musicians' (Vol. V, pp. 53–65, New York 1911).

TEMPERANCE. This word has long been used to characterize the movement for the temperate use of intoxicants and for the activities of societies of abstainers and those favoring a restriction of the use and sale of alcoholic beverages. The records of all the early peoples of the world contain references to the evils of intoxication. The Buddhists, Taoists and Confucians taught temperance. «Look not thou upon the wine when it is red . . . At the last it biteth like a serpent,— and stingeth like an adder.» (Prov. xxiii, 31–32). The ancient philosophers and founders of the great world religions neither taught nor practised total abstinence and these conditions furnished the religious reasons for advocating «temperance» rather than «total abstinence» from intoxicants. With the development of the manufacture of spirituous or distilled liquors, containing a much larger percentage of alcohol than those of natural fermentation, the evils of intoxication multiplied and temperance sentiment developed and increased. At first the agitation against liquor was sporadic, yet there was a pronounced sentiment developed in both Europe and America in the 18th century. In 1743 Lord Lonsdale made a speech in the English House of Lords, urging the necessity for a temperance reform. In 1760 Smollett called the attention of the English people to the signs «Drunk for 1d» and «Dead drunk for 2d.» He made an urgent appeal for improvement in the condition of the low alehouses. Yet it was not until 1829 that record is found of a temperance society in Great Britain, at New Ross, County Wexford, Ireland. In 1830 several temperance societies came into being in English cities and the British and Foreign Temperance Society was founded in 1831. It lasted until 1850, but in the meantime its work was taken up by others. Father Theobald Mathew (q.v.), of Cork, Ireland, began his campaign for temperance about 1838 and within three years he gathered about him more than 4,000,000 followers. The best evidence of the thoroughness of his work is that the consumption of liquors in Ireland fell off one-half during the period of his activity. In 1843 he was called to England and in 1850 to America, where he founded the numerous Father Mathew Total Abstinence Societies.

There had been considerable temperance agitation in the States before Father Mathew's arrival. The Washingtonian movement started in Baltimore in 1840 and John B. Gough (q.v.) had begun his wonderful talks for temperance. The influence of Mathew and Gough was evident in the formation of the Independent Order of Good Templars, founded in 1851 in Utica, and spreading rapidly all over the United States and to foreign countries. A woman's crusade for temperance started about 1870 and crystallized in the National Woman's Christian Temperance Union, founded in Cleveland in 1874 and now having 12,000 local unions throughout the United States. Frances E. Willard (q.v.) who was prominent in the work, founded the world's Woman's Christian Temperance Union in 1883, and it has become the largest and most influential movement for temperance and prohibition. It can scarcely be said, however, that the United States has led in temperance societies. Great Britain and her colonies far exceeded America in the number of societies organized, doubtless partly because her territory is so widely distributed. A list of prominent temperance societies in 1905 included United Kingdom 62, Germany 12, Australia 11, Switzerland 11, United States 10, Austria-Hungary 8, Holland 6, Sweden 6, Denmark 5, France 4, Belgium 2, etc.

Temperance agitation has influenced legislation for 75 years, but still the use of intoxicants has gone on with little interference except locally. As a result temperance agitators have gradually come out stronger and stronger for prohibition of both the manufacture and sale of intoxicants and the temperance movement has merged into the Prohibition movement, though in its inception Prohibition was the work of the more radical reformers. See PROHIBITION.

Temperance Legislation.— Legislation against the liquor evil in America dates from 1642, when the colony of Maryland passed a law making drunkenness a misdemeanor, punishable by a fine of 100 pounds of tobacco. As sentiment against intoxication developed the license system was adopted, as a temperance measure, being popular in communities also because it furnished a revenue for the local government. Soon the license system won the approval of the liquor sellers, for it stopped competition in their business, resulted in uniform prices and, therefore, contributed to money-making. Though advanced and introduced by advocates of temperance, the license system was fostered and grew directly through the efforts of the liquor-sellers. Temperance workers then began to advocate no license and a vast amount of legislation developed in the different States over licenses, their revocation or suspension, at the will of the people. Restrictive legislation took the form of local option laws and after the War of 1861–65 the local struggles at the polls of half the cities and towns in the country for years were centred mainly about the question of license or no-license. The establishing of local option in a community had a tendency to drive the lovers of liquor to the neighboring towns where there was license; thus the temperance towns lost their license fees, and saw their bibulous citizens going to other places to drink and also to trade. Often the result was that the financial pressure caused a return to license. There was great wavering between license and no-license almost all over the country. The first State to recognize that this irregular system could be overcome only by the States acting as a unit was Maine, which in 1851, under the influence of the Gough and Mathew movements, adopted State local option, and as a State continued to refuse to license the liquor traffic. Kansas and North and South Dakota followed, and in 1881 Maine placed the prohibitory clause in her constitution and ended the agitation for a return to licensed liquor-selling.

But in other States the contests at the polls continued regularly. Indiana was the first State to pass a local option law in 1832, and several other States had followed by 1850. By 1900 one-third of the country was under local option, and in 1911 local option existed by enactment in 33 of the States. Between 1890 and 1910 appears to have been the most active years with State legislatures in passing laws to restrict and regulate the liquor traffic. Most of the States passed Sunday closing laws, though allowing the hotels to sell liquor to their customers with meals. There was legislation permitting wives and children of drunkards to bring civil suits against any selling liquor to their provider. There were laws against the locating of saloons within so many feet of churches, schools or polling places. But these laws were largely honored in the breach. Sunday closing never was effective in the large cities, except spasmodically, as some mayor or chief of police became active. Public sentiment condoned the open backdoor as a rule, and it was and is (1918) the common practice with saloons in large cities. In country liquor shops the selling on Sunday is confined to those who are known personally to the proprietor to be safe.

The effort to improve conditions by high license was equally ineffective. When this was proposed the argument was that nine-tenths of the saloons would go out of business, and that the evil would be confined to those who had the liquor habit and who would drink anyway. This proved to be sophistry. The communities got more money by the high license system and it caused the liquor forces to become more active in politics, until in very many cities and towns a man could rarely be chosen to public office unless he was acceptable to the liquor interests.

A perpetual difficulty with obtaining temperance by all these various methods of legislation was that they failed to strike at the manufacture or the transportation of liquor. Though Maine prohibited liquor selling for years, the agents of the United States government obtained large sums in revenue from liquor that went into Maine, carried there with no attempt to stop it, by the express companies. And this form of nullifying the no-license law in local option communities was notoriously common. The no-license law only stopped the sale of liquor as a beverage over the counter; the individual still had a right to buy it by the barrel, and have it expressed to his home, and give it to his friends, and the best hotels were permitted to place it on their tables as part of the food supplied. The fact that some thousands of statutes in the different States were useless in attaining the end of temperance at length became apparent to the most obtuse. The manufacture and consumption of liquors in the United States had a slow and steady increase all through these years of antagonistic legislation, up to 1913, since which date there has been a very slight per capita reduction. The per capita consumption of malt liquors during the past 100 years in the United States slowly and steadily increased up to 1907, after which it fell off a small fraction. The per capita consumption of distilled liquors had a slight but steady decrease from 1865 to 1896. Thereafter it increased until 1907, since which it has been variable. But this trifling decrease in distilled liquors was evidently but a change to malt liquors, for the latter grew as the former reduced, and the whole calculation is based on per capita use, the volume of liquors made and sold being always on the increase up to 1907, and the falling off then appeared to be due more to financial stringency than to moral suasion or obedience to law. All these experiences with legislation that accomplished little or nothing taught the public that they were being fooled, and that the powerful financial interests in the liquor trade were always able to guide legislation or block it, or prevent its enforcement, so that in the end the trade was unharmed. As a result agitation for temperance legislation practically ceased, and those who opposed the liquor traffic worked for Prohibition (q.v.).

TEMPERANCE, Sons of, or THE ORDER OF THE SONS OF TEMPERANCE, was organized in the city of New York, 29 Sept. 1842. It is composed of subordinate, grand and national divisions. It has four national divisions — one for North America, one for Great Britain and Ireland and two for Australia. In the course of its existence it has had nearly 4,000,000 members on its rolls. Its fundamental and inalienable principle is total abstinence from all intoxicating liquors and beverages.

TEMPERANCE LEGISLATION. See TEMPERANCE.

TEMPERANCE SOCIETIES. See TEMPERANCE; TEMPERANCE, SONS OF, or THE ORDER OF THE SONS OF TEMPERANCE.

TEMPERATURE. See HEAT; THERMOMETER; THERMOMETRY; THERMOYDYNAMICS; ZERO.

TEMPERATURE OF THE BODY. See ANIMAL HEAT.

TEMPERATURE VARIETIES. See VARIATION.

TEMPERATURES, Underground. See UNDERGROUND TEMPERATURES.

TEMPERING, the art of imparting to metals, by means of heat treatment, a definite degree of hardness. The term is now applied almost exclusively to certain kinds of steel, which are used in the manufacture of tools. It is said that the ancients could harden and temper copper; but this art, if it ever really existed, is now lost. The effects of thermal changes upon steel vary greatly with the quality of the steel and with the exact nature of the treatment. It is necessary to distinguish clearly between «annealing,» «hardening» and «tempering.» Any steel (except those varieties that are alloyed with silicon, tungsten and certain other elements) may be annealed, but it is essential that the steel shall contain a certain amount of carbon, in order that it may be capable of being hardened and tempered. If steel is raised to a red heat and is then allowed to cool very slowly, it becomes relatively soft, so that it can be filed and turned in a lathe. This process is called «annealing,» and it has usually been held that the slowness of the cooling is the essential thing in the softening process. There is excellent reason for believing, however, that the exact temperature to which the steel is exposed before it is cooled has a much greater influence than the rapidity of the cooling. It has been shown, for example, by the researches of Brinel, Tschernoff, Le Chatelier, Heyn, Ridsdale, Stead and others that steel which has acquired a dangerously crystalline character from annealing for a long time at too low a temperature in a slightly oxidizing atmosphere, or from long continued heating at high temperatures, may have its original structure and properties restored by the simple artifice of heating it to a certain critical temperature (which is about 1,600° F.), and then allowing it to cool; the rate of cooling, in this case, being a matter of comparative unimportance. Steels may sometimes be had which do not need special treatment to render them fit for use in certain classes of tools; the tool being ready for use after it has been forged and allowed to cool by natural exposure to the air. In general, however, a tool steel must receive special treatment in order to fit it for the work in hand; this treatment being given after the tool has been forged to shape. The process of tempering then consists of two steps, the first of which consists in imparting to the cutting edge of the tool a degree of hardness that is too great for the work for which the tool is to be used, while the second step consists in reducing (or «tempering») this hardness, until it attains a value that experience has shown to be satisfactory. The tempering of an ordinary tool may be described as follows: The finished tool is heated to a bright red, care being taken to have the heat extend back some distance from the cutting edge. The cutting edge of the tool is then immersed in water to a slight depth and kept there until it has cooled sufficiently to remain wet when withdrawn from the water. By this means the steel is rendered exceedingly hard throughout the chilled part; that is, in the vicinity of the cutting edge. If it were used in this condition, however, the edge would be too brittle and would be likely to break in service. To reduce the hardness to the proper value, the tool, immediately after being withdrawn from the water, is brightened up near the cutting edge with a piece of emery cloth, or in some similar manner, and the cleaned area is then watched while the heat from the unquenched part spreads toward the cutting edge. The oxidization of the steel, as the edge becomes hotter and hotter from conduction, causes a play of color to become visible, which serves as an index of the temperature. These colors run from the hot portion of the tool toward the quenched cutting edge. In the order in which they proceed, they may be described as pale yellow, straw yellow, brownish yellow, light purple, dark purple and blue. When the proper color reaches the cutting edge, the whole piece is again quenched, and the «tempering» is complete. The colors that are used for different implements are as indicated below:

Very pale yellow (about 430° F.): Steel-engraving tools, turning tools, hammer faces, planer tools, wood-engraving tools.

Straw yellow (about 460° F.): Dies, taps, drills, punches, reamers.

Brown yellow (about 500° F.): Gouges, plane irons, twist drills, cooper tools, wood-boring cutters.

Light purple (about 530° F.): Augurs, surgical instruments, cold chisels, edging cutters.

Dark purple (about 550° F.): Axes, gimlets, needles, hack-saws, screwdrivers, springs, wood saws.

Some tools are of such a shape that they cannot be tempered in the manner here described, but must have their temper «drawn» to the desired color by reheating the piece between hot iron plates, or in a hot iron ring. Springs are often tempered by a different method, known as «oil tempering.» In carrying out this method, the piece is first hardened by heating to a bright red heat and then quenching by plunging the whole piece in water or in oil. The article to be tempered is then wetted with oil and gradually and uniformly heated until the oil upon it blazes up, when the piece is again quenched in the oil. This process of heating to the ignition point of the oil and then quenching is repeated until it has been performed three times, after which the piece is said to be «oil tempered,» and is ready for use.

In the early days of steel-working in the United States, it was common to import water in casks from Sheffield, England, for hardening and tempering purposes, as it was believed that there is some special virtue in the water that had been used for so long, and with such eminent success, in that city. There was probably little or no foundation for this belief, and yet it is known that substances that may be in solution in the water that is used for quenching often have an important influence upon the product. Many artisans dissolve salt or cyanide of potassium in the water that they use for this purpose, and there is considerable ground for the belief that such dissolved substances do exert an influence upon the character of the product, which is out of all apparent proportion to the strength of the solutions containing them. In particular, it may be noted that there is a deeply-rooted belief among blacksmiths and other artisans who work with metals that a piece of steel cannot be hardened by heating it and then quenching it in water that contains soap, even in small amounts.

The art of tempering cannot be adequately presented in a short article, and those who are skilled at it maintain (probably quite justifiably) that the only way to learn it is by actual experience in the shop. Different steels may require radically different treatment, and special implements (razors, for example) may call for years of study before they can be tempered satisfactorily.

ALLAN D. RISTEEN.

TEMPEST, The. Although certain internal evidence, notably the verse-test, has caused most scholars to believe that ‹The Winter's Tale› was the last of Shakespeare's plays, there will always be reason in thinking that ‹The Tempest› (written in 1610 or 1611) best represents the final mood of Shakespeare as he turned from the writing of his plays to the last years of his life in Stratford. It is certainly one of the group of romantic comedies which Shakespeare wrote after the completion of his tragedies; and in the character of Prospero we are warranted in seeing an adumbration of Shakespeare's personality as he looked out upon the world from the heights of his later years. He, like Prospero, broke his wand and buried his book deeper than did ever plummet sound. After all, while life may be tragical as presented in the series of plays from ‹Hamlet› to ‹Timon of Athens,› it is also full of sunshine and humor and the forgiveness of enemies and the reconciliation of the forces of good and evil. ‹The Tempest› is such a representation of life. While some of the scenes of the play suggest definitely Milan and Naples, Tunis and the intervening Mediterranean Sea, the enchanted island upon which Prospero lived is on none other than the uncharted deep that voyagers were bringing within the compass of man's imagination. In the grotesque figure of Caliban, the magic of Prospero and the spirit-like world of Ariel, there is the atmosphere of the strange world that stood out in definite contrast with the fixed limits of the European world. More particularly, Shakespeare was indebted to the story of a fleet of ships that had set out from England in 1609, was wrecked in the Bermudas a few weeks after and finally reached the newly-established colony in Virginia. While, as has been suggested, he might have heard from returning seamen stories of this wreck and of the strange happenings in the New World, he was especially indebted to Silvester Jourdan's ‹The Discovery of the Bermudas,› published in 1610. Professor Alden has recently made good his contention that the real source for the description of the storm and for the incidents that take place upon the strange island is found in a letter written by William Strachey, dated 15 July 1610, and which, though not published until 1625, was, from contemporary evidence, seen by Shakespeare. The parallelisms between the play and the letter are most striking and certainly tend to show that the author's indebtedness to contemporary sources was far greater than has been generally supposed. The ideal commonwealth suggested by Gonzalo, while based upon Florio's translation of Montaigne's essays, a new edition of which was published in 1610, bears a striking resemblance to conditions in the Virginia colony as portrayed in the letter.

However far one may go in the acceptance of these parallels, the play is none the less the creation of Shakespeare's genius. While it is lacking in the perfect technique of some of his plays, and especially in the closeness of dramatic structure, it is a great poem and it lends itself to allegorical interpretation as do few of the plays. Caliban is a monumental representation of a primitive type of humanity, rejoicing in unrestricted freedom and in the saturnalia of license. Ariel, more than Puck, represents the spiritual forces of nature under the domination of superior wisdom and for the service of man. Prospero, both in his magical art and in his intellectual and spiritual greatness, is an anticipation of the triumphant victory of man at his best over all the forces of the world. There is no greater utterance of Shakespeare than the words in which Prospero, looking out from the serene heights which he has reached, expresses the ultimate truth about man and the universe:

> "We are such stuff
> As dreams are made on, and our little life
> Is rounded with a sleep."

EDWIN MIMS.

TEMPLAR, Knights. See MASONIC FRATERNITY, THE.

TEMPLE, Frederick, English prelate, archbishop of Canterbury: b. Santa Maura, Ionian Islands, 30 Nov. 1821; d. London, 23 Dec. 1902. He was the son of an English army officer who died while he was a child, and under his mother's care was well educated in youth, so that he obtained a «double first» at Oxford and was elected Fellow and tutor of his college. After his ordination in 1846 he took charge of Kneller Hall, Twickenham, and from 1848 to 1858 was school inspector. In the latter year he was made headmaster of Rugby and became one of the most powerful and influential successors of Arnold. The publication of ‹Essays and Reviews,› in which series Temple led off with ‹The Education of the

World,' roused a storm of acrimonious controversy, but did not shake confidence in the headmaster of Rugby, who was appointed bishop of Exeter in 1869, was translated to London in 1885 and succeeded Archbishop Benson in 1896. Equally as schoolmaster and as bishop he was a strict disciplinarian, an untiring worker, a blunt, just and sincere man whose plainness of address did not obscure the massive learning with which his mind was stored. The great controversial storms of the century had spent their fury in the English Church before he reached the primacy, but his incumbency was not uneventful. The Tractarian movement was in its last phase of ritualism, and Temple handled ritualists with firmness and moderation. He took part in the queen's diamond jubilee (1897) and in 1902 placed the crown on the head of her successor. His writings are 'Sermons in Rugby Chapel' and Bampton Lectures for 1884 on 'The Relations between Religion and Science,' of which it may be said that they were up to the standard set by previous lecturers and were not unworthy of the future primate of All England. He died in harness, never recovering from the effort he made in a strong appeal in the House of Lords uttered in favor of the public education bill.

TEMPLE, Oliver Perry, American lawyer and author: b. Green County, Tenn., 27 Jan. 1820. He was graduated from Washington College, Tenn., in 1844, and admitted to the bar in 1846. He was a Union leader in East Tennessee during the Civil War; was a chancellor of Tennessee, 1866–78, and retired from the bar in 1881. His publications include 'The Covenanter,' 'The Cavalier and the Puritan' (1897); 'Union Leaders of East Tennessee' (1903), etc.

TEMPLE, Richard Carnac, English civil servant and antiquary: b. Allahabad, India, 15 Oct. 1850. He was educated at Cambridge University. He served in the Burma War 1887–89 and received a medal for bravery. From 1887–93 he was engaged by the Indian government to raise and fit out volunteer regiments. He has published 'Wide Awake Stories' (1884); 'Legends of the Panjab' (1883–90), etc., and is a member of philological and other learned societies.

TEMPLE, Sir William, English statesman: b. London, 1628; d. Moor Park, Surrey, 27 Jan. 1699. He was educated at Cambridge, spent six years on the Continent and returning in 1654, and not choosing to accept any office under Cromwell, occupied himself in the study of history and philosophy. On the Restoration he was chosen a member of the Irish convention, and in 1661 was returned for the county of Carlow. The following year he was nominated one of the commissioners from the Irish Parliament to the king, and removed to London. On the breaking out of the Dutch War, he was employed in a secret mission to the bishop of Münster which he executed so much to the satisfaction of the ministers that in the following year he was appointed resident at Brussels, and received a baronetcy. With De Witt he concluded the treaty between England, Holland and Sweden (February 1668), with a view to oblige France to restore her conquests in the Netherlands. He also attended, as Ambassador Extraordinary, when peace was concluded between France and Spain at Aix-la-Chapelle, and subsequently residing at The Hague as Ambassador, enjoyed the friendship of De Witt, and also of the Prince of Orange, afterward William III. A change of politics led to the recall of Temple in 1671, who, refusing to assist in the intended breach with Holland, retired from public business, and employed himself in writing his 'Observations on the United Provinces,' and part of his 'Miscellanies.' In 1674 Temple was again Ambassador to the States-General, in order to negotiate a general pacification. Previously to its termination in the Treaty of Nimeguen (in 1678), he was instrumental in promoting the marriage of the Prince of Orange with Mary, eldest daughter of the Duke of York, which took place in 1677. In 1679 he was recalled from The Hague, and shortly afterward was elected to represent the University of Cambridge in Parliament. In 1681 he retired from public life altogether. He was on friendly terms with William III who occasionally visited him. (For his relations with Swift see SWIFT, JONATHAN). His 'Memoirs' are important as regards the history of the times, as are likewise his 'Letters,' published by Swift after his death. His 'Miscellanies' consist of essays on various subjects: 'Gardening,' 'The Cure of the Gout,' 'Ancient and Modern Learning' (which provoked much controversy at the time), 'Health and Long Life,' 'Different Conditions of Life and Fortune,' 'Introduction to the History of England,' 'Poems and Translations,' etc. Consult Courtenay, 'Life of Temple' (1836); Macaulay's 'Essay' and Forster, 'Life of Swift' (Vol. I, 1875).

TEMPLE, Tex., city in Bell County, on the Gulf, Colorado and Santa Fé and the Missouri, Kansas and Texas railroads, about 220 miles northwest of Galveston, and 35 miles southwest of Waco. It was founded in 1882 by the Gulf, Colorado and Santa Fé Railroad, and was chartered as a city the same year. It is in an agricultural and stock-raising region and has considerable manufacturing interests. The chief manufacturing establishments are agricultural-implement works, cottonseed-oil mills and cotton compresses, flour mills, chewing gum and candy factory and lumber mills. The city has handsome churches, public and parish schools, Saint Mary's Academy, two kindergartens, a business college, three large hospitals and a public library. The four banks have a combined capital of $580,000. Pop. 10,993.

TEMPLE, London, England, a district of the city lying between Fleet street and the Thames, and divided by Middle Temple Lane into the Inner and the Middle Temple, belonging to separate societies (see INNS OF COURT), each with its hall, library and gardens. The name is derived from the Knights Templars, who had their headquarters in England here. The two temples are separated by a wall from the rest of the city, and have entrance gates which are closed at night. The district is occupied, with few exceptions, exclusively by barristers and solicitors. In former times the members of the Temple were famous for the masques, revels and banquets which they gave in their halls. To these entertainments there are many allusions in the old poets; kings attended them, the benchers joined in them and directed the students to dance. Among famous members of the Temple have been Beaumont, Sir Walter Raleigh, John Ford, Wycherley, Congreve, Cowper, Blackstone, Sheridan, Coke, Littleton, Clarendon, Somers and Eldon. Goldsmith and Johnson had chambers here, and here Charles Lamb was born and passed the first seven years of his life.

TEMPLE, a name applied in religious history particularly to the temple built by Solomon at Jerusalem as a House of the Lord, and to the temples which succeeded it, more especially the magnificent structure, erected by Herod the Great, which is often mentioned in the New Testament. Solomon's Temple was built with the aid of an architect and skilled workmen from Phœnicia. The temple was an oblong stone building, 60 cubits in length, 20 in width and 30 in height. On three sides were corridors, rising above each other to the height of three stories, and containing rooms in which were preserved the holy utensils and treasures. The fourth or front side was open, and was ornamented with a portico, 10 cubits in width, supported by two brazen pillars, Jachin and Boaz (stability and strength). The interior was divided into the most holy place or oracle, 20 cubits long, which contained the ark of the covenant, and was separated by a curtain or veil from the sanctuary or holy place, in which were the golden candlesticks, the table of the shew-bread, and the altar of incense. The walls of both apartments and the roof and ceiling of the most holy place were overlaid with wood work, skilfully carved. None but the high-priest was permitted to enter the latter, and only the priests devoted to the temple service the former. The temple was surrounded by an inner court, which contained the altar of burnt-offering, the brazen sea and lavers, and such instruments and utensils as were used in the sacrifices, which, as well as the prayers, were offered here. Colonnades, with brazen gates, separated this court of the priests from the outer court, which was likewise surrounded by a wall. This temple was destroyed about 586 B.C. by the Assyrians, and after the return from the Babylonish captivity some 70 years later, a second temple of the same form, but much inferior in splendor, was erected. Herod the Great rebuilt it, beginning the work about 20 B.C., of a larger size, surrounding it with four courts, rising above each other like terraces. This being the temple of the time of Christ possesses great interest. The lower court was 500 cubits square, on three sides surrounded by a double, and on the fourth by a triple row of columns and was called the court of the Gentiles, because individuals of all nations were admitted into it indiscriminately. A high wall separated the court of the women, 135 cubits square, in which the Jewish females assembled to perform their devotions, from the court of the Gentiles. From the court of the women 15 steps led to the court of the temple, which was enclosed by a colonnade, and divided by trellis-work into the court of the Jewish men and the court of the priests. In the middle of this enclosure stood the temple, of white marble richly gilt, 100 cubits long and wide, and 60 cubits high, with a porch 100 cubits wide, and three galleries like the first temple, which it resembled in the interior, except that the most holy place was empty, and the height of Herod's temple was double the height of Solomon's. Rooms appropriated for different purposes filled the upper story above the roof of the inner temple. This edifice was destroyed by the Romans in 70 A.D., and for many centuries the long-consecrated height has been occupied by the Mosque of Omar.

The Egyptians, Greeks, Romans, Persians, and other ancient nations had temples for the worship of their gods, and the Mexicans and Peruvians, at the time of the arrival of the Spaniards in the New World, had splendid temples. On the sacrificial platforms of Aztec temples thousands of victims perished annually. The Greek and Roman temples were, as a rule, models of architectural grandeur and beauty. The word «temple» is sometimes, but not often, applied to Christian places of worship as a special designation, although frequently used in a figurative sense. The Mormons designate as «The Temple,» the large structure in which they worship at Salt Lake City. Consult Fergusson, James, 'The Temple of the Jews' (1878); Smith, G. A., 'Jerusalem' (1908). See ARCHITECTURE.

TEMPLE, Order of the. See ORDERS, ROYAL.

TEMPLE BAR, London, England, an arched gateway which formerly stood between Fleet street and the Strand, and divided the city from the liberty of Westminster. (See LONDON). It was a structure of the Corinthian order, designed by Sir C. Wren, and built in 1670 of Portland stone. Over the gateway, on the east side, were statues of Queen Elizabeth and James I; and on the west side, of Charles I and II. The heads of persons executed for high treason were formerly exhibited on this gate. Here, also, on particular occasions, the corporation of London received the royal family, the heralds' proclamations, or any distinguished visitors. When the sovereign came in state the lord-mayor here delivered to him the sword of state, which was returned, and after this he rode bareheaded, immediately in front of the royal procession. As the gate seriously obstructed a crowded thoroughfare, it was removed in 1878, its site now being marked by the heraldic monster, a «griffin.» The gate has been re-erected at Theobald's Park, Cheshunt.

TEMPLE UNIVERSITY, an institution of higher learning founded at Philadelphia in 1884 by Russell H. Conwell, pastor of the Baptist Temple. It was chartered by the State in 1888, and empowered to grant degrees in 1891, its name being changed from Temple College to Temple University in 1907. It was designed to offer instruction to young men whose occupations kept them busy during the day, and at first only evening instruction was offered; in 1891 a day school also was added. There are 18 departments with a range from kindergarten and academic to the highest university courses. Instruction is arranged in morning, afternoon and evening classes in all branches except medicine and dentistry, in which there are only day classes. The university is non-sectarian, but is of a strongly religious atmosphere, and accomplishes a notable work in assisting those who could not otherwise obtain high educational advantages. In 1918 there were 321 instructors; 2,192 students attending and 306 with the colors.

TEMPO (time), *in music*, the relative rate of movement or degree of quickness with which a piece of music is to be executed. The degrees of time are indicated by certain words such as *lento* (slow), *adagio* or *largo* (leisurely) *andante* (walking pace), *allegro* (gay or quick), *presto* (rapid), *prestissimo* (very rapid), etc. *A tempo* is the proper time. (See MUSIC). The word is also used in chess to indicate the period of a move, especially when the move is wasted.

TEMPORAL BONE See ANATOMY; SKULL.

TEMPORAL POWER (OF THE POPE). By this expression, in its generally received signification, is understood the sovereign civil rule which was exercised by the popes over the states of the Church with varying vicissitudes from the middle of the 8th century down to the year 1870, when the last remnant of the papal states was annexed to the United Kingdom of Italy.

The formal establishment of the temporal power dates from the year 754, when Pepin, king of the Franks, bestowed upon Pope Stephen II (who had sought his aid against the oppression of the Lombards) independent sovereignty over some 20 cities, thus constituting what was henceforth known as the state or patrimony of Saint Peter. Though apparently a new departure — one possibly unlooked for on the part of the Pope himself — this addition of a temporal to the spiritual rule of the bishop of Rome was in reality but the natural outcome of pre-existing civil and political conditions. Among these may be mentioned the fact that the Roman Church was already in possession of numerous and extensive landed estates or patrimonies situated for the most part within the bounds of the Italian peninsula, and which were controlled or administered by the popes through their agents.

This state of things had gradually developed from very early beginnings, for we find that even during the period of the persecutions, the local church of Rome (whether organized legally as a burial society, or simply as a body corporate, holding property under the general laws of the empire) possessed not only the great cemeteries now known as the Catacombs, but also other property, as is clear from the edict of Milan. By a law of 321, the Emperor Constantine granted to all persons capable of making a will the right to bequeath property to the Church, and he himself gave an example of generosity in this respect by endowing munificently the various basilicas of Rome. Similar bequests in one form or another were made by wealthy Christians throughout the empire, one of the principal uses to which the property thus acquired was applied being to relieve the distress occasioned by the depredations of the barbarians who began to overrun Italy from the beginning of the 5th century. In this way the Roman Church had become very wealthy, and the popes were already great landed proprietors, owning vast estates in various parts of Italy and elsewhere long before any form of political papal sovereignty had been thought of. Meanwhile, through the favorable legislation of the Christian emperors, the political rôle of the popes and of bishops in general, was assuming an ever-growing importance. The bishop of a city was not only the official protector of the poor, of prisoners and of slaves; he had also in virtue of his office a voice concerning various points of civic administration. Even in provincial affairs he enjoyed important rights and privileges. Thus, among other things, we find that appeal could be made from the decision of an imperial magistrate to the tribunal of the bishop. Such being the political status of bishops generally, it is easy to understand that the powers granted to and exercised by the Roman pontiffs were still more extensive. To them, in particular, recourse was had against the exactions of the rapacious Byzantine governors who ruled in the different Italian provinces, and in this connection, as well as in other ways, the vigilant protection of the popes proved beneficial to the people. It must be remembered that during this period the civil and political situation throughout the peninsula was in a condition bordering on the chaotic. The chronic state of unrest and insecurity which resulted from the incursions of the barbarians and the deplorable inefficiency of the imperial administration, made the interference of the popes in civil matters a real practical necessity. Theirs was the only authority that commanded general respect, and the common weal demanded that they should look after the material as well as the spiritual interests of their flock. That such was the true condition of affairs is amply shown forth in the papal correspondence of the time, especially in the letters of Gregory the Great (590–604). It is also worth noting that though they had ever-growing reasons to be dissatisfied with Byzantine rule, the popes (even those who succeeded Gregory) continued to remain faithful to the idea of a world-wide Christian empire, and exercised their influence to maintain in Italy its authority and prestige. But, as is well known, many of the emperors of that period were more preoccupied with theology than with matters pertaining to civil administration, and their repeated attempts to impose upon the bishops of the West subtle formulas of orthodoxy led to frequent conflicts, in some of which popes were violently dragged away to prison or death. Thus Silverius and Vigilius, Pelagius and Martin became the victims of imperial tyranny. On the refusal of Sergius I to accept the decrees of the Emperor Justinian II the latter commanded the protospatharius Zachary to arrest the Pope and bring him a prisoner to Constantinople, but the public spirit in Italy was already in revolt against this arrogant, high-handed policy, and the army interfered to prevent the execution of the imperial mandate. Again, in 727, Leo the Isaurian sent his edict against the use of images to Pope Gregory II with orders for his deposition in case he should refuse to comply. Gregory responded by denouncing the edict and excommunicating the exarch; again the soldiers arose in his defense, and the efforts of the imperial officers to carry out their instructions cost them their lives. In 733 the emperor confiscated all the Church's estates in Sicily, Bruttium, Lucania, Calabria and Naples; others were confiscated by the Lombards, and no security remained even for the inhabitants of Rome. The empire was unable to defend its subjects — worse than that, it even oppressed and plundered them. The only refuge left to the Romans and their spiritual as well as actually temporal head was to seek the aid of the friendly king of the Franks. It is not clear whether Pope Stephen II in taking this step had already in view the establishment of a civil principality under his own rule or not, but be that as it may, just then the relations between the papacy and the emperor were further strained by the publication of a fresh edict against the use of images emanating from a synod of Constantinople. A continuation of the old régime seemed no longer possible, the army of Pepin arrived in Italy in the summer of 754, and the independent state of Saint Peter was established, with the Pope as its civil ruler, in the same year. In view of the circumstances, it may be truly said that this distinction was bestowed upon the bishop of Rome in recognition of a twofold prerogative, namely, his prestige as head of the Church and defender of orthodoxy against Eastern aggression, and his character of national benefactor.

The papal dominion as constituted by the grant of Pepin comprised the cities of Ravenna, Rimini, Pesaro, Fano, Casena, Forli Commachio and 15 other towns. In 1053 the duchy of Benevento was annexed, and between that period and the end of the 13th century the authority of the Roman See was acknowledged by many other free towns in Italy. In 1278 the Emperor Rudolf I confirmed the acquisitions made thus far, defined the boundaries of the papal states, and recognized the Pope's exclusive authority over them by absolving the inhabitants from their oath of allegiance to the empire. The papal dominion then included Perugia, Bologna, Bertinoro, the duchy of Spoleto, the exarchy of Ravenna and the marche of Ancona, but many of the towns were more or less independent. The Romagna was annexed at the end of the 15th century. Under Alexander VI and Julius II were added Faenza, Parma, Placentia and Reggio, and the papal states received their final additions in the 17th century, namely, Urbino, Ronciglione and the duchy of Castro. In 1797 the Romagna was seized by Napoleon and incorporated into the Cisalpine Republic. The following year Rome itself was taken by the French and the papal states were erected into the Roman Republic. Pius VII regained possession of his states in 1800, but they were soon retaken by the French, and finally (1809) incorporated with France, Rome being reckoned the second city of the empire. After the downfall of Napoleon (1814) Pius VII returned to Rome and was formally reinstated in his office of temporal ruler by the treaty of Vienna, mainly through the friendly support of the non-Catholic powers Russia, Prussia and England. In 1830 a rebellion broke out in Ancona and Bologna, the reason alleged by the insurgents being that the clerical rule in the provinces contrasted too unfavorably with the preceding French administration. This revolt was quelled through the aid of Austria, but another uprising occurred soon after, and the Austrians took occasion thereby to occupy the northern legations, while at the same time the French placed a garrison in Ancona. Occasional minor disturbances occurred between these events and 1848, when Pius IX, on account of an insurrection, was obliged to flee to Gaeta and Rome was declared a republic. The Pope was again restored to power through the armed intervention of France, Austria, Spain and Naples, and the Austrians occupied the northern legations or Romagna on his behalf until 1859, when their army was withdrawn. Soon after the province repudiated its allegiance to the Pope and its annexation to Sardinia was proclaimed. The French still continued to hold Rome in subjection to papal authority and Pius IX, with a view to withstand any further encroachments upon his dominions, raised an army, which was placed under the leadership of the able French general, Lamoricière. In the meantime Garibaldi and his followers, whose aim was the political unification of the Italian states under the rule of Victor Emmanuel, were conducting a successful campaign in Sicily and Naples. The news of this caused an outbreak in Urbino and the Marches in favor of Victor Emmanuel. The Sardinian troops came to the aid of the insurgents and after two encounters with the troops under Lamoricière compelled the latter to surrender with his whole army after a week's siege in Ancona (1860). The revolted provinces of Umbria, Urbino and the Marches, as well as the isolated provinces of Benevento and Pontecorvo, situated within the kingdom of Naples, were immediately annexed to Sardinia. Finally, on 20 Dec. 1870, the French troops having been withdrawn on account of the war with Prussia, Rome was entered practically without resistance by the troops of Victor Emmanuel, and the last vestige of temporal power disappeared. Victor Emmanuel having been proclaimed king over united Italy, took up his residence in the papal palace of the Quirinal and Pius IX withdrew to a life of seclusion (in the Vatican). considering himself as a prisoner unable to leave his retreat without compromising his dignity as head of the Church, or even giving occasion to riots and bloodshed. He never ceased to protest emphatically against the spoliation of his rights as a temporal ruler and against the presence of the king and his court in the papal city. Leo XIII, though departing in many respects from the policy of his predecessor, maintained nevertheless throughout the same uncompromising attitude toward the question of the temporal power, and the same policy was steadfastly affirmed by his successor, Pius X. Such are, in briefest outline, the main facts pertaining to the origin and history of this ecclesiastico-civil institution. It is beyond the scope of the present article to appreciate or criticize the motives either of those who labored to maintain it or of those who more or less directly sought its abolition. Still less pertinent to the purpose in view would be a speculation on the probable restoration of the same in the future. It must be granted that, considering the present political situation in Europe, the probability of a restoration of the temporal power, at least in its ancient form, seems rather remote. For all practical intents and purposes the different powers recognize as a *fait accompli* the incorporation of the papal dominions into the kingdom of Italy; though, on the other hand, it still remains true that this state of affairs has never yet received any formal, international ratification. Furthermore, the necessity, or even the utility, of such a restoration is a point concerning which there is considerable divergence of opinion even among Roman Catholics. It is a question concerning which no authoritative dogmatic pronouncement has been formulated by the Church; however, the firm and unmistakable attitude of the popes toward it cannot be looked upon by Catholics otherwise than deeply significant. All, even the most ultra-montane, must, of course, admit that the possession of a temporal sovereignty is not an essential prerogative of the successor of Saint Peter, since for so many centuries before it was established the Church was able to develop and fulfil so efficiently her mission in the world. Yet this temporal sovereignty is regarded by many as the means providentially established to protect the necessary independence of the Pope and the free exercise of his functions as spiritual head of the Church. Others, while admitting the main principle involved (namely, that the Pope should be free in his spiritual capacity) take a somewhat different view of the case. They remind us that the temporal power was the outcome of peculiar and to a great extent abnormal conditions. It was the best and perhaps the only solution at the time, and for centuries afterward of a vexed problem, partly political, partly religious; but at the same time it is not proved that had the conditions been otherwise some other régime of papal supremacy just as satisfactory would not have developed. But be that as it may, it is claimed that at least in the present social and political conditions of the Christian world, so different from those of the Middle Ages, the desired independence in spiritual matters can be secured without imposing on the Pope the burden of a temporal as well as a spiritual sovereignty. When, however, it is asked how this can be done, no very clear or satisfactory answer is forthcoming. It is plain from the nature of the case, as well as from past experience — notably the sojourn of the papacy at Avignon — that to have the Pope under the control or protection of any secular prince is dangerous for the best interests of religion. If the head of the Church be not himself an independent sovereign, it is hard to conceive a situation in which he would be free from undue political or national influence, especially if he is to be either the subject or guest of some temporal ruler. It is for a similar reason that the founders of the American Republic wisely determined that the seat of the central or federal government should be located not in any of the States, but in a separate independent district, exempted from State jurisdiction, thus insuring greater freedom of action to the governing body whose duty it is to legislate impartially in the interests of the entire nation. These and other reasons are urged by the advocates of the temporal power and when it is not unreasonably objected that during the third of a century that has elapsed since the occupation of Rome by Victor Emmanuel the Pope has always enjoyed full freedom in the exercise of his spiritual jurisdiction; that never before has the moral influence of the papacy been so powerful and far-reaching, etc., the answer is made that while all this is true, there is nevertheless no sufficient guaranty that this liberty will continue to be granted in the future; that, moreover, the present situation of the papacy is certainly abnormal, and that the increase of moral influence is due in great part to the fact that the popes have maintained a firm attitude, refusing to become the allies of the Italian government. Not a few are of the opinion that in the present political status of the civilized world a system of international guaranties would be a much more effectual means of securing for the Pope the permanent free exercise of his spiritual jurisdiction than could result from a restoration of the temporal power. However that may be, the most thoughtful statesmen allow that the problem is complicated and delicate — that no solution thus far arrived at or suggested is free from grave practical difficulties. The temporal power of mediæval and later times was certainly not without grave drawbacks and disadvantages as regards the interests of both rulers and subjects. That it has been the occasion of many evils and abuses, that it has often been a real impediment to the spiritual efficiency of the papacy few impartial students of history will venture to deny; yet it will doubtless be as readily admitted that being given the circumstances of the period the temporal power was a most useful, even necessary, factor in the evolution of Christianity; and whatever may be thought of its adaptability to future contingencies it will not be a matter for surprise to find that so many are still convinced of its permanent necessity, at least until something better shall have been devised to meet the exigencies of the case, and shall have demonstrated its superiority by actual experience.

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JAMES F. DRISCOLL, D.D.,
Rector, Saint Gabriel's Church, New Rochelle, N. Y.

TEN COMMANDMENTS. See DECALOGUE.

TEN KATE, Jan Jacob Ludewijk, Dutch poet: b. The Hague, 1819; d. 1889. See KATE JAN JACOB LUDEWIJK TEN.

TEN THOUSAND A YEAR, a novel by Samuel C. Warren (q.v.) published in 1841. This story, though regarded by critics as «ridiculously exaggerated and liable to the suspicion of being a satire on the middle classes,» has held a certain place in fiction for more than half a century. The plot is ingenious, the legal complications are managed in a way that won the admiration of accomplished lawyers and the story with all its faults contrived to arouse and maintain the reader's interest. In 1902 it was reissued in an abridged form as 'Tittlebat Titmouse.'

TENACITY, the property or quality of resistance to disrupting force; the quality by which the molecules of a body resist either tensile or crushing strain. When the tenacity is slight the object may be brittle, when it is great it adheres together firmly. Compare TENSILE. See STRENGTH OF MATERIALS.

TENAFLY, N J., borough in Bergen County, 16 miles northwest of New York, on the Erie Railroad. The Happy Land and Bethmore summer outing homes for children are situated here as well as the Mary Fisher Home for the Aged. It is a residential town, forming a suburb of New York, and there are manufactures of decorative burlaps. Pop. 3,050.

TENAINO, tē-nī'nō. See SHAHAPTIAN INDIANS.

TENANCY, a beneficial interest in some form of real property, or the relation of the lessee of land to the lessor of the same. This relation may be established without that the lessor be the holder in fee simple of the realty in question. At the present time the status of a tenant is usually created by a form of conveyance known as a lease; this is now required to be in writing in most jurisdictions. It usually contains covenants or stipulations respecting the use to which the realty may be put, the rent or compensation to be paid the lessor, the making of repairs, etc. The law also regulates the relations of the tenant to his landlord in some important respects. Thus the tenant is protected against eviction by the landlord. The tenancy may be sub-leased unless there is a restriction in this regard in the lease. A surrender or breach of the lease terminates a tenancy. See LANDLORD AND TENANT.

TENANT. See RENT, LAW OF.

TENANT-RIGHT, in British law, a right possessed by the tenant, at the expiration of his tenancy, for reimbursement for improvements, and often of considerable monetary value. It is largely governed in England by statute. Tenant-right prevailed in some parts of Ireland by custom for many years, and was formally incorporated into the law by an act passed in 1870. It is also applied to the preference given to old tenants over strangers in leases from the Church, the Crown or corporations.

TENASSERIM, tĕ-năs'ĕ-rĭm, India, a maritime division of lower Burma, stretching in a narrow strip from the Salwin River 500 miles southward into the Malay Peninsula, between Siam and the Bay of Bengal. Area, 36,086 square miles. It is for the greater part a mountainous wilderness. Within its territory are the Mergui Archipelago. Maulmain is the chief town on the north and Tavoy in the central area. The chief product is rice, though the mountains are rich in minerals. The natives are chiefly Burmese Buddhists. Pop. about 1,400,000.

TENCH, a small cyprinoid fish (*Tinca vulgaris*), familiar in European fresh waters, especially slow-running and muddy rivers. The color is a greenish olive, tinted with a golden hue; the average length about 12 inches. The flesh is soft and rather insipid.

TENDA PASS, or **COL DE TENDA,** Italy, a pass of the Maritime Alps, Piedmont, in the province of Cuneo, between Tenda and Limone, on the carriage road from Nice to Cuneo. Its highest point is 6,195 feet above sea-level.

TENDER, in law, a formal offer of compensation or damages made in a money action. A tender may be made through an authorized agent, and to make it valid the money must be actually produced. Making a tender may have the effect of freeing the defender from subsequent expenses if the tender is found sufficient. A tender made to one of several joint claimants is held as made to all. A legal tender is one of legal money of the country, originally confined to coin, but extended to authorized paper money. A payment in foreign notes or «trade» dollars, or a large sum in bronze pennies, is not a legal tender.

TENDON, or **SINEW,** a band of white fibrous tissues by which a muscle is attached to a bone or other hard part. Tendons are disposed in elastic bands or layers flattened or rounded, and more or less elongated. When very much flattened and membraneous, they are called aponeuproses and sometimes fasciæ. They glide smoothly in sheaths, especially in the extremities; in some cases many are enveloped in a single sheath, in other situations they are kept in place by an annular ligament, as in the wrist and ankle. One of the most important is the Achilles tendon (q.v.), at the heel. One of the most beautiful contrivances in the human body is the manner in which the superficial flexor tendons in the fingers stop short at the middle phalanx and divide to allow the tendons of the deep flexor to pass through to the terminal phalanx, thus securing compactness and beauty of shape, with freedom and extent of motion. Contractions of tendons are frequently remedied by subcutaneous tenotomy; torticollis (q.v.) is also benefited by the division of the tendon of the sternomastoid muscles. Inflammation of the tendon sheaths, or tenosynovitis, about the wrist or ankle is a common and painful affection usually due to strain or over exercise. Rest and mild counter irritation are the principal elements in the treatment. The violent strain of a tendon, less than a rupture, is called a sprain (q.v.). When a tendon is ruptured or cut nature makes an effort to rejoin it by growing or depositing new tissue in the gap.

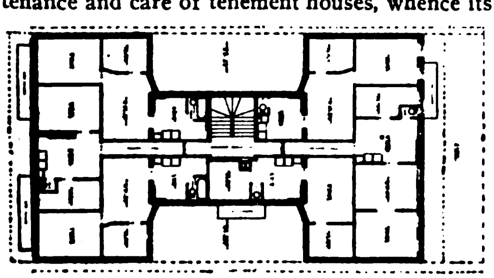
TENDRAC. See TANREC.

TENEBRÆ, in the Roman Catholic Church the matins and lauds of Wednesday, Thursday and Friday of Holy Week, sung on the preceding evenings. The ceremony dates from the 8th century. The services begin with 15 lighted candles which are extinguished one by one until the last, which is hidden, the church meantime being darkened. The growing darkness as a candle is extinguished after each hymn betokens the fading light of the world as Christ was leaving it, while the light of the hidden candle brought forth at the end of the service indicates the coming resurrection and that death could only appear to triumph over Christ. In English mediæval churches 24 candles were used at the service.

TENEDOS, tĕn'ĕ-dŏs, Asia Minor, an island in the Ægean Sea, off the Troas Coast, belonging to Turkey. It lies at the entrance to the Dardanelles, hence has figured in naval operations on several occasions. It is six miles long by three miles wide, is of volcanic formation, with rugged surface, but highly fertile, and celebrated for its wine. Pop. 5,000.

TENEMENT HOUSE, a multiple dwelling arranged for the occupation of several families, each of which can live independently and do its cooking within its apartment. The legal definition varies somewhat in different cities. In New York, Philadelphia, Washington, Buffalo and other cities, it is such a house for more than two families. In Chicago, Boston and Saint Louis the line is drawn at more than three families. Tenement house is a generic term, including what are popularly called apartment houses and flat houses or flats, as well as tenements. The attempt has sometimes been made in framing tenement-house laws or regulations to distinguish between apartment and tenement houses, but no satisfactory line of separation has ever been suggested, nor is there any legal regulation properly applicable to tenement houses, as popularly defined, which should not equally apply to apartment houses, or which presumably would not be adopted by intelligent owners of such houses from motives of self-interest.

Tenement-House Reform.—A movement to better the housing conditions of the working classes in cities, which originated about the middle of the 19th century and has gradually become national in character in the United States and Great Britain. In the United States it has taken the form of the regulation by State law or city ordinance of the construction, maintenance and care of tenement houses, whence its



A tenement with no room opening on a court narrower than 12′ 6″, with every room light and well ventilated, and with separate water-closets for each apartment and baths for some

title. In Great Britain this movement has been directed to all kinds of houses, including tenement houses, and is usually called by its more generic title of «Housing Reform.» The initiative of the movement has been benevolent impulse, but the strong forces behind it which have given impulse to that initiative and have united to carry the movement forward have been the same which have evolved sanitary and building regulations and are founded quite as much on self-interest as altruism.

History.— The movement for tenement-house reform in the United States naturally began in New York, its largest city, where the need for regulation first became apparent, and may be said to date from 1842, when Dr. John H. Griscome, the city inspector of the board of health, called attention to tenement conditions in a special report on the sanitation of the city. It has since extended to almost all large cities in which tenement houses have been erected, and has taken the form sometimes of State law, as in New York and Massachusetts, or more often of city ordinance, as in Chicago and Philadelphia. The legislation in New York is the result of the investigations and recommendations of successive State commissions, and the scope of inquiry of the last commission, which is typical, has been «To make a careful examination into the tenement houses in cities of the first class; their condition as to the construction, healthfulness, safety, rentals and the effect of tenement-house life on health, education, savings and morals of those who live in tenement houses and all phases of the so-called tenement-house question in these cities that can affect the public welfare.» The chief subjects of tenement-house regulation may be grouped under three general classes: protection against fire and means of escape in case of fire, light and ventilation and sanitary protection, the latter including water supply, water-closet accommodation and the prevention of overcrowding.

Fire Protection — Protection against fire is almost universal. Structural provisions directed to this end are contained in the building laws of all cities. In New York, Philadelphia, San Francisco, Jersey City, Providence, Syracuse and Nashville all tenements must have fire escapes. All tenements over two stories in height must have fire escapes in Saint Louis, Baltimore, Louisville, Minneapolis, Saint Paul, Denver, Toledo and Columbus. In Chicago, Cleveland and Cincinnati this rule only applies to tenements over three stories in height. In many cities tenements must be fire-proof throughout when over a certain height. In Philadelphia this is true of all over four stories; in Washington of those over five stories; in New York, Buffalo, Louisville, Minneapolis and Denver of those over six stories in height. In Boston the limit is 65 feet.

Light and Ventilation are protected by minimum open spaces and by a limitation of the percentage of a lot which can be occupied by a building. In Philadelphia there must be open spaces at the side or rear, equal to one-fifth of the lot area, and the minimum width of all spaces is eight feet. In Buffalo, under the local law in force before the general State act of 1901 was passed, the minimum width of any outer court was six feet in two-story buildings, eight feet in three- and four-story buildings and one additional foot in width for each additional story. The minimum interior court was 8 by 10. In Boston, a clear open space at the rear must be left equal to one-half the width of the street on which the tenement fronts and there must be two open spaces at least 10 feet wide. In some cities the required court area is expressed in square feet, without regard to minimum width or length and increases proportionately with the height of the building. This principle is adopted in New York, where the minimum width of exterior courts in buildings five stories high is six feet on the lot line and 12 feet between wings and the minimum area of interior courts on the lot line in buildings of the same height is 12 by 24. These dimensions are increased or decreased according as the building is higher or lower. Tenement houses in New York must have an open yard at least 12 feet wide in the rear. The maximum percentage of lot area which may be occupied by the building differs, properly, according as the lot is an interior or a corner lot. As respects interior lots, this limitation in New York and Buffalo is 70 per cent; in Boston 65 per cent; in Philadelphia 80 per cent. The height of rooms is almost universally regulated, the minimum usually being eight feet. The height of tenements is limited in many cities. In New York it is limited to one and one-half times the width of the street on which it faces.

Water Supply.— In New York water must be furnished on each floor. In Philadelphia and Buffalo, on each floor, for each set of rooms. In Boston, Chicago, Jersey City and Kansas City, in one or more places in the house or yard. Water-closet accommodation is very generally prescribed. In Philadelphia and in New York, under the law of 1901, there must be one for every apartment. Under the previous law in New York, there must be one for every two families. In other cities the unit is the number of persons. It is 20 persons in Boston, Baltimore and Denver; 10 persons in Rochester.

Law Enforcement.— The enforcement of Tenement-House Law in American cities is usually vested in existing city departments to which it is most germane. These provisions, which relate to the construction of new buildings and the alteration of old ones, are naturally enforced by a building department or by whatever part of a city government has charge of the enforcement of building regulations. Sanitary regulations are, for a like reason, usually enforced by a board of health or by whatever city officer supervises the enforcement of health laws in general. In the city of New York previous to 1901 the enforcement of such regulations was divided between the building department, the health department, the fire department and the police department. Under such divided responsibility many of them were not enforced at all, and the enforcement of others was extremely lax. Moreover, the tenement-house problem in New York was an exceptionally large one. Of its population at that time of nearly 3,500,000, nearly 2,500,000, or more than two thirds, lived in tenement houses as legally defined. Under these circumstances the State commission of 1900 recommended the establishment of a separate tenement-house department in the city of New York. This department was established under the new charter of the city which went into operation in 1902 and centres in itself all the municipal duties toward tenement houses and their inmates, as such, which were previously divided among the other city departments.

Model Tenements.— The erection of model tenements, so-called, of large size, from motives primarily philanthropic, has been less frequent in the United States than in Great Britain. The best known and earliest are the "Home Buildings" and "Tower Buildings," which were erected by Alfred T. White in Brooklyn; the first named in 1879. The erection of these buildings, which have been financially successful from the start, was an epoch in the cause of tenement reform. It led indirectly to the Tenement-House Law of 1879. Among the most successful model tenements are those of the City and Suburban Homes Company of New York. In the United States 616 cities now take an active interest in housing, and in 124 model housing enterprises have been launched.

Great Britain.— The movement for housing reform in Great Britain has had a somewhat different direction from its American counterpart. The evils there have been more largely slum conditions than those resulting from tall buildings and unventilated and unlighted rooms. The particular evils of the tall tenement practically exist only in Edinburgh and Glasgow. Consequently English and Scotch effort has been directed mainly toward the demolition of unsanitary areas and more recently, the erection of municipal tenements by the city governments themselves. These movements, at first local, and authorized under local acts, such as the Glasgow Improvement Act of 1866 and the Liverpool Sanitary Amendment Act of 1868, have been made general by the Housing of the Working Classes Act of 1890 and many slum areas have been destroyed and municipal tenements built in their place, notably in the cities of London, Glasgow, Manchester, Liverpool and Edinburgh. Tenement-house regulation in Great Britain emphasizes the same general subjects and follows the same lines as American regulation. Limitations upon height are general and more drastic than in America. Such houses are limited in London to 80 feet, without special consent of the council and may not exceed the distance between the front wall of the building and the opposite side of the street in streets less than 50 feet wide. In Edinburgh they are limited to one and one-quarter times the width of the street; in Liverpool and Glasgow to the actual width of the street; in Manchester to two stories in streets of less than 30 feet in width and to three stories in wider streets up to a width of 36 feet. Tenement regulations on the Continent usually form part of the general building regulations. The regulations for Paris and Berlin are very elaborate, but proceed under the same general lines as in English and American cities. In Berlin, houses fronting on the street may only be as high as the width of the street. In Paris a somewhat greater latitude is allowed in this particular.

No American city has imitated the English example of building municipal tenements, nor has such action ever been seriously proposed. Serious objections to any such extension of the sphere of municipal activity would exist in any American city. Moreover, municipal building would discourage and restrict building by private enterprise, which has proved sufficient to meet the demand. The problem is too large for any American city to deal with it successfully by the use of any amount of public funds likely to be put at its disposal for such purposes. Halfway measures by preventing private enterprise would only increase the evil which they sought to remedy.

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TENERIFFE, tĕn-ėr-ĭf', the largest of the Canary Islands. It is 60 miles long, 10 to 25 miles wide and has an area of 782 square miles. The coasts are precipitous and the interior rises in the volcanic Peak of Teneriffe or Pico de Teyde, to a height of 12,192 feet. This mountain has been quiescent for two centuries. The soil is very fertile and produces dates, coco-palms, fruit, grain, cotton, sugar and grapes. The chief town and the capital of the Canary Islands is Santa Cruz de Tenerife, situated on the northeastern coast. The Spanish government has established there a large wireless telegraph station. Pop. of the island about 180,000. See CANARY ISLANDS.

TENIERS, tĕn'yėrz (Fr. tä-nē-ār), **David,** THE ELDER, Flemish artist: b. Antwerp, 1582; d. there, 29 July 1649. Having studied under Rubens, he went to Rome and remained there 10 years. On his return to his native country he occupied himself principally in the delineation of fairs, shops, rustic sports and drinking parties, which he exhibited with such truth, humor and originality, that he may be considered the founder of a style of painting which his son afterward brought to perfection. He also painted some landscapes with scriptural or mythological figures in the foreground. A picture from his hand was sold in 1886 for $2,275. His 'Dutch Kitchen' in the New York Metropolitan Museum gives a fair example of his style. This canvas is 45½ by 39 inches and, therefore, much larger than the majority of his pictures.

TENIERS, David, THE YOUNGER (son of the preceding), Flemish artist: b. Antwerp, 15 Dec. 1610; d. Brussels, 25 April 1690. He received his early instruction in his art from his father and his style was improved by copying 200 pictures in the gallery of Archduke Leopold William to whom he had been appointed painter. This copying degenerated into servile imitation and he produced such perfect facsimiles that they deceived even connoisseurs, and he has been styled the «Ape of Painting.» Yet he had also a strong vein of originality and his paintings of low life in Flanders are excellent examples of genre. Although refined in mind and manners and patronized by such men as Prince John of Austria, son of the Emperor Charles V, he preferred to immortalize by his brush the card table and drinking party of boors and was to the last the enthusiastic painter of the pot-house and the guard-room with its rollicking soldiery. There are at least 2,000 of his pictures at present in existence, six of them being hung in the New York Metropolitan Museum of Art, though none of these latter excepting 'A Marriage Festival,' can be called representative of the artist's style and quality. Like Rubens, some of whose manner he inherited from the teaching of his father, a pupil of the former, he was a rapid executant; many of his works are mere sketches, others elaborated with exquisite virtuosity. His touch is light but sure and his coloring exceptionally fine, while for animation and power of expression he remains the first of Flemish genre painters. His works are highly prized and his 'Village Fete' was sold in 1850 for $15,750. Consult Rosenberg, 'Teniers der Jüngere.'

TENNANTITE, an isometric, metallic mineral, isomorphous with tetrahedrite. It is essentially a copper sulph-arsenite, differing from tetrahedrite into which it passes by insensible gradations, only in the preponderance of arsenic instead of the antimony which distinguishes the latter. Its color and streak are usually iron-black; it often has a brilliant metallic lustre; its hardness varies widely from 3 to 4.5; its specific gravity is also quite variable, 4.4 to 5.1. It occurs in fine specimens in the mines of Cornwall, England, in Bolivia and Colorado. When sufficiently abundant it constitutes a valuable copper ore.

TENNESSEE, tĕn-nĕs-sē («THE VOLUNTEER STATE»), a southern-central State of the United States. Kentucky and Virginia lie to the north; North Carolina to the east; Georgia, Alabama and Mississippi to the south; and Arkansas and Missouri to the west. Its length on the northern side is 436 miles; that on the southern side is 100 miles less. The area is approximately 42,050 square miles, of which something like 300 miles are covered by the water of streams. The southern boundary of Tennessee was intended to follow the 35th parallel, but all parts of it lie from a fraction of a mile to a mile south of that line, excepting the 45 miles east of Tennessee River, between Alabama and Tennessee. That part of the northern boundary between Tennessee and Mississippi rivers is on the parallel of 36° 30'. Immediately east of Tennessee River, the northern boundary is 12½ miles north of parallel 36° 30'. Eastward from this point the boundary is not straight but on the whole approaches that line, coming within approximately five miles of it, in the middle of Claiborne County. Here there is a jog of about a mile to the north. There is a similar but somewhat greater one in the eastern part of Sullivan County. It was the intention to make the crest of the Great Smoky or Unaka Mountains the eastern boundary between Tennessee and North Carolina. The most eastern point of the State is in Johnson County, and is approximately 81° 41¼′ W. longitude. The western boundary is the middle of the Mississippi River as the channel ran in 1763, at the time of a treaty between the British and French. The most western point is in Shelby County, and is approximately 90° 28′ W. longitude.

Surface Features.— Tennessee has eight well-defined natural divisions: (1) On its eastern borders rises in great ridge-like masses and treeless domes the main axis of the Appalachian chain, the loftiest peaks of which reach an elevation of 6,600 feet above the sea. Many beautiful valleys and coves nestle amid this grand range of mountains, which is known as the Unaka or Smoky Mountains, and which has an area, approximately, of 2,000 square miles. (2) Adjoining these mountains on the west is the second natural division, called the Valley of East Tennessee, which lies between the Unakas on the southeast and the Cumberland Mountains on the northwest. This valley has a fluted bottom, made up of a succession of minor ridges and valleys with a northeast-southwest trend. Viewed from the mountains on either side, these minor ridges and valleys melt into a common plain. This valley has an area of 9,200 square miles and is of great agricultural value. It is the southwestward extension of Shenandoah Valley of Virginia. (3) Next in order, going westward, is the Cumberland Plateau, which rises 2,000 feet and more above the sea, and 1,000 feet above the last-mentioned division. It forms a bold escarpment, on its eastern edge presenting a gray, rocky, formidable rampart. Its western edge is irregular and jagged, notched and scalloped by re-entrant coves and valleys which are separated by finger-like spurs, pointing for the most part in a northwesterly direction. Most of the northern part of the plateau is cut to pieces by deep, narrow ravines, between which are sharp-topped ridges. The southern half is divided lengthwise into two parts by the deep-cut Sequatchie Valley. The area of this division is 5,100 square miles. (4) Resting against the western edge of the Cumberland tableland and including the elevations bordering the Tennessee River in its return across the State are the Highlands, or Rimlands, having an average elevation of 900 feet above the sea. For the most part this division is a flat plain furrowed by numerous ravines traversed by streams. Its area is 9,300 square miles and it surrounds, in an irregular circle, the next division. (5) Surrounded by these Highlands lies the Central Basin, elliptical in shape, with an area of 5,450 square miles. It is the finest agricultural region in the State, and is on an average of 300 feet lower than the Highlands that border it. (6) The valley of the Tennessee River comes next on the west. Its surface is broken and irregular, and it stretches across the State from south to north on both sides of Tennessee River. It has an average width of 12 miles and an elevation of 350 feet. Its area is approximately 1,200 square miles. (7) The slope of West Tennessee constitutes the seventh natural division and differs from all the other divisions mentioned in having but few hard rocks, these occurring only in a narrow belt north of Savannah and bordering the Tennessee River. It is a great plain, that with the exception of a belt about 20 miles wide next to Tennessee River, slopes gradually toward the Mississippi. For the most part, the surface is gently rolling, but in places is furrowed with low valleys bordering streams that flow in sluggish currents to the Mississippi. Its area is 8,850 square miles, with an average elevation of 500 feet. It abruptly terminates in a line of bluffs that overlooks the great alluvial plain or bottom lands of the Mississippi River, next to be mentioned. (8) The Mississippi Bottoms constitute the eighth and last of the natural divisions of the State. It is a low, flat plain, studded with lakes and originally clothed with dark forests. Much of its area lies below the high water of the Mississippi, and as a result there are many swamps and marshes. The area of this division is 950 square miles, and its elevation above the sea is 300 feet.

A very singular topographic feature already referred to is Sequatchie Valley, which is a deep trough extending in a northeasterly direction from the south boundary of the State, dividing the southern end of the Cumberland tableland into two unequal arms, the eastern one being known as Walden's Ridge. The valley has its head about midway between the northern and southern boundaries of the State, and is about 60 miles long and from three to five miles wide. It is enclosed by rocky walls, approximately 1,000 feet high, and through its centre flows the beautiful Sequatchie River.

The highest point in the State appears to be Mount Guyot, which is near the corner of Cocke and Sevier counties, and which stands 6,636 feet above sea-level. Other points that exceed 6,000 feet are Mount Henry, Roan Mountain, Clingmans Dome, High Knob, Mount Le Conte, Mount Curtis, Mount Safford and Master Knob. They all, with few exceptions, are on or near the line that separates Tennessee from North Carolina. There are a few points near the eastern border of the Cumberland Plateau which rise above 3,000 feet.

The Allegany range of Pennsylvania and Virginia becomes the Cumberland Plateau in Tennessee, and Sand Mountain in Alabama. The Blue Ridge of Pennsylvania, Virginia and North Carolina takes the name of Unaka or Smoky Mountains in Tennessee. Many of the long, straight valleys of the valley of East Tennessee lying between the parallel ridges and overlooked by them are rich, populous and beautiful — centres of industry, intelligence and a diversified system of agriculture. Taking the State altogether it will be seen that the topography is greatly diversified. The great elevations on the east are offset by the low valley of the Mississippi on the west. Between these are three great plateaus and two marvelously fruitful valleys, all differing in height, area, soils, climate and products. It is indeed a State of the greatest variety in natural features.

Drainage.— The Mississippi, the Tennessee and the Cumberland form the great drainage basins of the State. The Tennessee and Cumberland are tributaries of the Ohio, which in turn flows into the Mississippi so that all the streams which drain the State, with the exception of a few insignificant ones that flow

TENNESSEE.

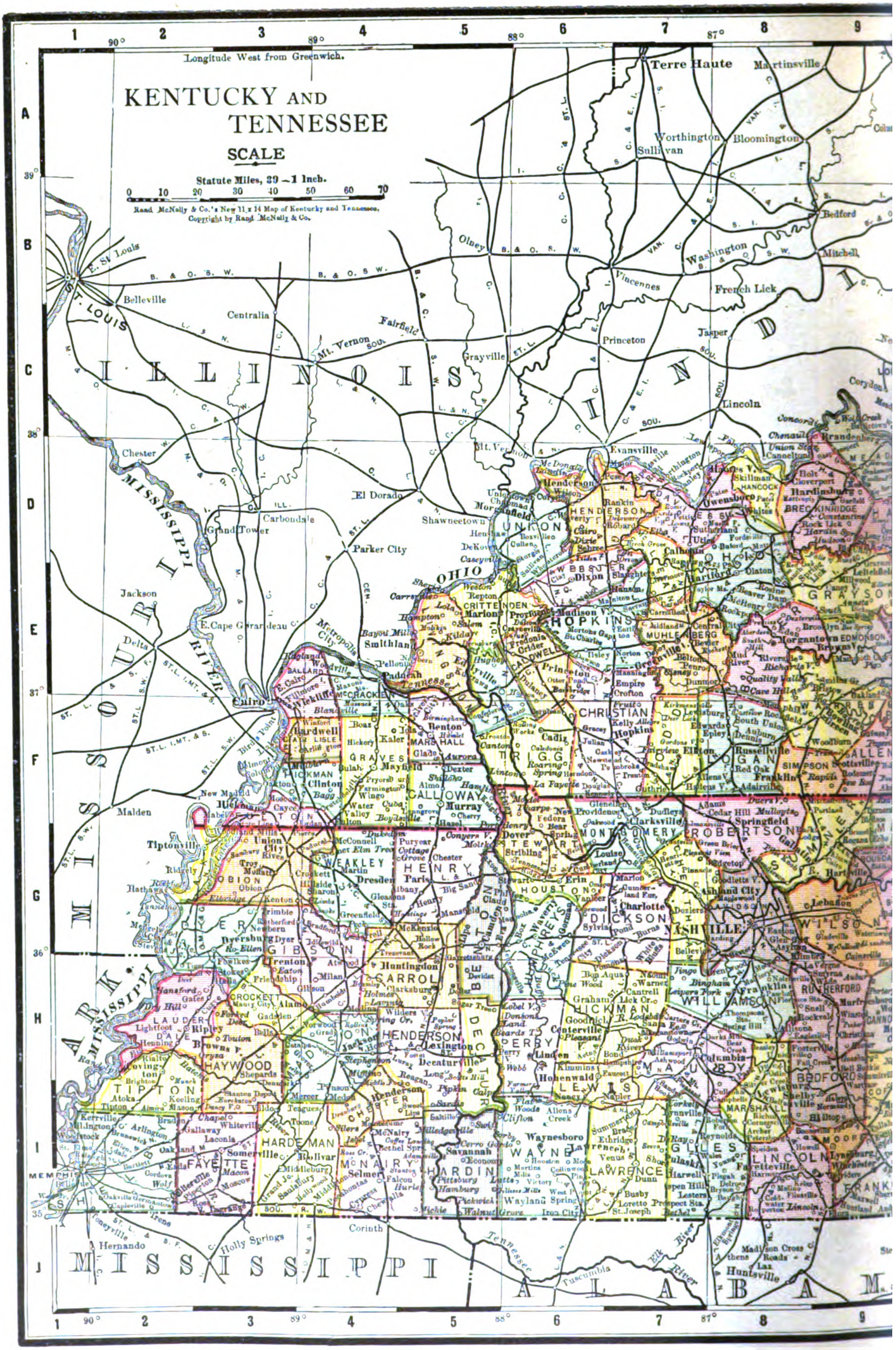
Estimated population, 2,288,004

COUNTIES

Pop.		
17,717	Anderson	G 13
12,667	Bedford	H 9
22,452	Benton	G 5
6,329	Bledsoe	H 11
20,809	Blount	H 14
16,336	Bradley	I 12
27,387	Campbell	G 13
10,825	Cannon	H 9
23,971	Carroll	H 5
19,838	Carter	G 17
10,540	Cheatham	G 7
9,090	Chester	I 4
23,504	Claiborne	G 14
9,009	Clay	F 10
19,399	Cocke	H 15
15,625	Coffee	I 9
16,076	Crockett	H 1
9,327	Cumberland	G 13
149,478	Davidson	G 8
10,093	Decatur	H 5
15,434	Dekalb	H 10
19,955	Dickson	G 7
27,721	Dyer	G 3
30,257	Fayette	I 3
7,446	Fentress	G 12
20,491	Franklin	I 9
41,630	Gibson	G 3
32,629	Giles	I 7
13,888	Grainger	G 14
31,083	Greene	G 16
8,322	Grundy	I 10
13,650	Hamblen	G 15
89,267	Hamilton	I 11
10,778	Hancock	G 15
23,011	Hardeman	I 3
17,521	Hardin	I 5
23,587	Hawkins	G 15
25,910	Haywood	H 3
17,030	Henderson	H 5
25,434	Henry	G 5
16,527	Hickman	H 7
6,224	Houston	G 6
13,908	Humphreys	G 6
15,036	Jackson	G 10
5,210	James	I 11
17,755	Jefferson	G 15
13,191	Johnson	G 18
94,187	Knox	G 14
8,704	Lake	G 2
21,105	Lauderdale	H 2
17,569	Lawrence	I 7
6,033	Lewis	I 7
25,908	Lincoln	I 8
13,612	Loudon	H 13
21,046	McMinn	I 12
16,356	McNairy	I 4
14,559	Macon	G 10
39,357	Madison	H 4
18,820	Marion	I 10
16,872	Marshall	I 8
40,456	Maury	H 7
6,131	Meigs	I 12
20,716	Monroe	I 13
33,672	Montgomery	G 7
4,800	Moore	I 9
11,458	Morgan	G 12
29,946	Obion	G 3
15,854	Overton	G 11
8,815	Perry	H 6
5,087	Pickett	F 11
14,116	Polk	I 12
20,023	Putnam	G 11
15,410	Rhea	H 12
22,860	Roane	H 12
25,466	Robertson	G 8
33,199	Rutherford	H 9
12,947	Scott	G 12
4,202	Sequatchie	I 11
22,296	Sevier	H 15
191,439	Shelby	I 2
18,548	Smith	G 10
14,860	Stewart	G 6
28,120	Sullivan	G 17
25,621	Sumner	G 8
29,459	Tipton	I 2
5,874	Trousdale	G 9
7,201	Unicoi	G 17
11,414	Union	G 14
2,784	Van Buren	H 11
16,534	Warren	H 10
28,968	Washington	G 17
12,062	Wayne	I 6
31,929	Weakley	G 4
15,420	White	H 11
24,213	Williamson	H 8
25,394	Wilson	G 9

Incorporated Cities, Towns, Etc.

Pop.		
542	Adams	G 8
490	Allens Creek	I 6
477	Arlington	I 2
641	Ashland City	G 8
2,264	Athens	I 12
263	Bartlett	I 2
110	Belfast	I 8
466	Bellbuckle	H 9
753	Bells	H 3
380	Big Sandy, Benton	H 5
1,673	Binghamton, Shelby (P.O. Memphis)	I 2
186	Bloomington Springs, Putnam	G 11
540	Bluff City	G 17
1,070	Bolivar	I 4
517	Bonair	H 11
7,148	Bristol	G 17
2,882	Brownsville	H 3
858	Brushy Mountain, Morgan	G 12
499	Butler, Johnson	G 18
161	Cades, Gibson	G 3
692	Camden	G 5
904	Carthage	G 10
467	Celina	G 10
1,097	Centerville	H 7
236	Charlotte	H 1
60,075	Chattanooga	I 17
8,548	Clarksville	F 2
5,549	Cleveland	I 16
711	Clifton	I 1
596	Clifty, White	H 13
1,090	Clinton	G 13
1,102	Coalcreek	G 13
802	Collierville	I 8
5,754	Columbia	H 1
1,848	Cookeville	G 18
290	Cornersville	I 5
215	Cottage Grove	G 2
2,990	Covington	H 1
763	Crossville	H 14
347	Cumberland Gap	G 15
447	Dandridge	G 11
1,991	Dayton	I 12
165	Decatur	I 19
1,022	Decherd	I 6
1,850	Dickson	H 4
708	Dresden	G 1
1,166	Dunlap	I 16
1,166	Dyer	G 3
4,149	Dyersburg	G 3
81	Eades	I 2
334	Eastland, White	H 11
2,478	Elizabethton	G 17
179	Elkton, Giles	I 7
58	Ellendale	I 2
943	Erin	G 6
1,149	Erwin	G 17
1,685	Etowah, McMinn	I 12
3,439	Fayetteville	I 8
304	Finley, Dyer	G 3
2,924	Franklin	H 8
408	Gainesboro	G 10
2,399	Gallatin	F 9
292	Gates	H 2
247	Germantown	I 2
233	Gibson	H 4
388	Gleason	G 4
422	Gordonsburg, Lewis	I 7
245	Gordonsville	G 10
491	Grand Junction	I 3
522	Green Brier	G 8
1,920	Greeneville	G 16
1,516	Greenfield	G 4
882	Halls	H 3
3,061	Harriman	H 13
1,087	Henderson	I 4
582	Henning	H 2
198	Henry	G 5
3,446	Humboldt	H 4
1,112	Huntingdon	H 5
253	Isoline	G 11
834	Jacksboro	G 13
17,807	Jackson	H 8
1,328	Jefferson City	G 14
1,862	Jellico	G 13
10,925	Johnson City	G 17
806	Jonesboro	G 16
815	Kenton	G 3
824	Kingston	H 13
38,676	Knoxville	H 13
2,816	La Follette	G 13
308	La Grange	I 3
1,687	Lawrenceburg	I 7
3,659	Lebanon	G 9
3,392	Lenoir City	H 13
1,830	Lewisburg	H 8
1,497	Lexington	H 5
1,421	Livingston	G 11
163	Longview, Bedford	H 8
2,391	Lonsdale, Knox	G 14
631	Lookout Mountain, Hamilton	I 11
995	Loudon	H 13
408	Lynchburg	I 9
596	Lynnville	I 7
661	McEwen	G 6
1,322	McKenzie	G 5
2,299	McMinnville	H 10
963	Manchester	I 10
2,228	Martin	G 4
2,381	Maryville	H 14
391	Mason	H 2
192	Mayland, Cumberland	G 11
320	Medina	H 4
148,995	Memphis	I 1
273	Middleton	I 4
1,605	Milan	H 4
554	Millington	I 1
1,107	Monterey	G 11
149	Morrison	H 10
4,007	Morristown	G 15
211	Moscow	I 3
592	Mountain City	G 18
1,436	Mountain View, Knox	G 14
1,973	Mt. Pleasant	I 7
329	Munford, Tipton	I 2
4,679	Murfreesboro	H 9
117,057	Nashville	G 8
1,602	Newbern	G 3
2,003	Newport	H 15
1,293	Obion	G 3
700	Oliver Springs	G 12
653	Orme	I 10
5,126	Park, Knox	G 14
3,881	Paris	G 5
379	Petersburg	I 8
227	Pleasant Hill	H 11
579	Portland	F 9
2,928	Pulaski	I 7
254	Puryear	G 5
240	Raleigh	I 1
481	Ravenscroft	H 11
154	Rheatown, Greene	G 16
324	Richard City, Marion	I 10
1,500	Ridgedale	I 11
519	Ridgely	G 2
43	Ridgetop	G 8
2,011	Ripley	H 2
468	Rives	G 3
3,660	Rockwood	H 12
1,242	Rogersville	G 16
142	Rossville	I 3
766	Rutherford	G 3
111	Samburg	G 3
435	Sardis	I 5
199	Saulsbury	I 3
529	Selmer	I 4
675	Sevierville	H 15
608	Sharon	G 4
2,869	Shelbyville	H 8
1,387	Somerville	I 3
1,391	South Fulton, Obion	G 2
2,106	South Pittsburg	I 10
1,409	Sparta	H 10
210	Spencer	H 11
1,039	Spring City	H 12
2,085	Springfield	F 8
695	Spring Hill, Maury	H 7
2,426	St. Elmo, Hamilton	I 11
400	Summertown	I 7
1,850	Sweetwater	H 13
886	Tazewell	G 14
391	Thomastown, Shelby	I 2
843	Tiptonville	G 2
245	Toone	I 4
2,402	Trenton	G 4
556	Trimble	G 3
529	Troy	G 3
3,049	Tullahoma	I 9
4,389	Union City	G 3
659	Wartrace	I 9
517	Watertown	G 9
947	Waverly	H 6
357	Waynesboro	I 6
298	Westmoreland, Sumner	G 8
370	West Point	I 6
419	White Bluff	G 7
741	Whiteville	I 3
1,351	Winchester	I 9
604	Woodbury	H 9


KENTUCKY AND TENNESSEE
SCALE
Statute Miles, 39 – 1 Inch.
0 10 20 30 40 50 60 70
Rand McNally & Co.'s New 11 x 14 Map of Kentucky and Tennessee.
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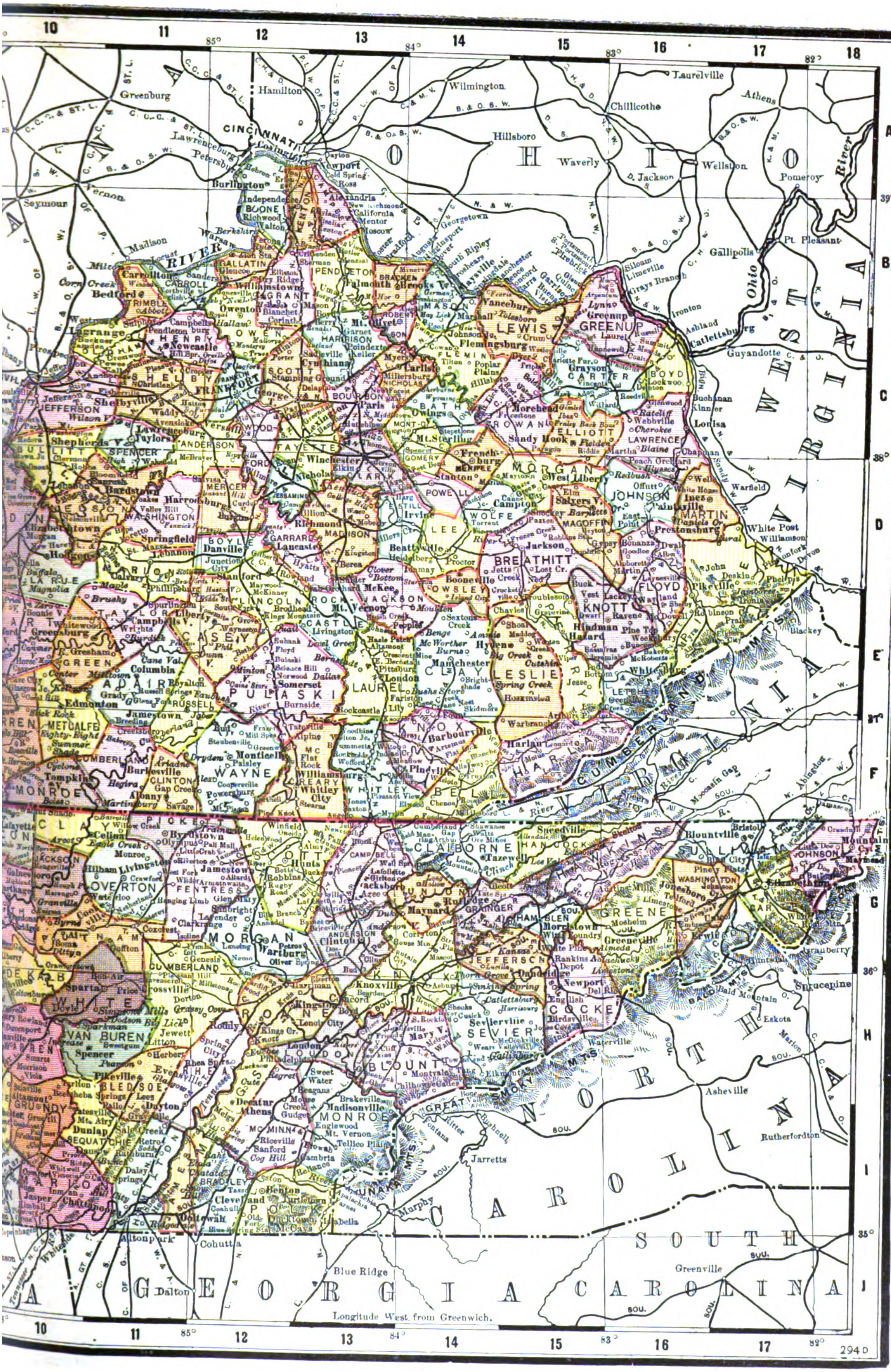
Longitude West from Greenwich.
ILLINOIS
INDIANA
MISSOURI
MISSISSIPPI
ALABAMA
ARK.
MISSISSIPPI RIVER
OHIO
Terre Haute
Martinsville
Worthington
Bloomington
Sullivan
Bedford
Olney
Washington
Mitchell
Vincennes
French Lick
E. St. Louis
St. Louis
Belleville
Centralia
Fairfield
Mt. Vernon
Grayville
Princeton
Jasper
Lincoln
Chester
El Dorado
Carbondale
Grand Tower
Shawneetown
Parker City
Evansville
Jackson
E. Cape Girardeau
Delta
Cairo
Metropolis City
Smithland
Paducah
Malden
New Madrid
Hickman
Tiptonville
Memphis
Hernando
Holly Springs
Corinth
Tuscumbia
Huntsville
Henderson
Owensboro
Morganfield
UNION
HOPKINS
CALDWELL
CRITTENDEN
Marion
Princeton
CHRISTIAN
Hopkinsville
TRIGG
Cadiz
CALLOWAY
Murray
GRAVES
Mayfield
HICKMAN
Clinton
Wickliffe
BALLARD
McCRACKEN
Benton
MARSHALL
Bardwell
Clarksville
MONTGOMERY
ROBERTSON
Springfield
SUMNER
Gallatin
NASHVILLE
DAVIDSON
WILSON
Lebanon
RUTHERFORD
Murfreesboro
WILLIAMSON
Franklin
MAURY
Columbia
GILES
Pulaski
LINCOLN
Fayetteville
BEDFORD
MARSHALL
LAWRENCE
WAYNE
Waynesboro
HARDIN
Savannah
McNAIRY
Selmer
HARDEMAN
Bolivar
FAYETTE
Somerville
SHELBY
TIPTON
Covington
HAYWOOD
LAUDERDALE
Ripley
Dyersburg
DYER
OBION
Union City
WEAKLEY
Dresden
HENRY
Paris
GIBSON
Trenton
CARROLL
Huntingdon
CROCKETT
Alamo
MADISON
Jackson
HENDERSON
Lexington
CHESTER
Henderson
DECATUR
Decaturville
BENTON
Camden
HUMPHREYS
Waverly
HOUSTON
Erin
STEWART
Dover
DICKSON
Charlotte
HICKMAN
Centerville
PERRY
Linden
LEWIS
Hohenwald
MUHLENBERG
Greenville
TODD
Elkton
LOGAN
Russellville
SIMPSON
Franklin
ALLEN
Scottsville
WARREN
Bowling Green
BUTLER
Morgantown
GRAYSON
EDMONSON
OHIO
Hartford
McLEAN
Calhoun
DAVIESS
WEBSTER
Dixon
HANCOCK
BRECKINRIDGE
Hardinsburg
Cloverport
Hawesville
Livingston
LIVINGSTON
LYON
Eddyville
Kuttawa


O H I O
WEST VIRGINIA
VIRGINIA
NORTH CAROLINA
SOUTH CAROLINA
GEORGIA
CINCINNATI
Hamilton
Wilmington
Hillsboro
Chillicothe
Laurelville
Athens
Waverly
Jackson
Wellston
Pomeroy
Gallipolis
Pt. Pleasant
Ironton
Ashland
Catlettsburg
Guyandotte
Louisa
Greenburg
Seymour
Vernon
Madison
Lawrenceburg
Burlington
Covington
Newport
BOONE
GALLATIN
CARROLL
TRIMBLE
HENRY
OWEN
GRANT
PENDLETON
BRACKEN
MASON
LEWIS
GREENUP
BOYD
CARTER
HARRISON
ROBERTSON
FLEMING
SHELBY
FRANKLIN
SCOTT
BOURBON
NICHOLAS
BATH
ROWAN
ELLIOTT
LAWRENCE
JEFFERSON
SPENCER
ANDERSON
WOODFORD
FAYETTE
CLARK
MONTGOMERY
MENIFEE
MORGAN
JOHNSON
MARTIN
BULLITT
NELSON
WASHINGTON
MERCER
JESSAMINE
MADISON
ESTILL
POWELL
WOLFE
MAGOFFIN
LEE
BREATHITT
FLOYD
PIKE
BOYLE
GARRARD
MARION
LA RUE
LINCOLN
ROCKCASTLE
JACKSON
OWSLEY
KNOTT
PERRY
LETCHER
TAYLOR
CASEY
GREEN
ADAIR
RUSSELL
PULASKI
LAUREL
CLAY
LESLIE
METCALFE
CUMBERLAND
CLINTON
WAYNE
McCREARY
WHITLEY
KNOX
BELL
HARLAN
MONROE
Frankfort
Lexington
Paris
Winchester
Richmond
Danville
Stanford
Somerset
London
Manchester
Hazard
Whitesburg
Pikeville
Prestonsburg
Barbourville
Pineville
Harlan
Middlesborough
Columbia
Jamestown
Burkesville
Albany
Monticello
Williamsburg
CUMBERLAND MTS.
CLAY
PICKETT
SCOTT
CAMPBELL
CLAIBORNE
HANCOCK
HAWKINS
SULLIVAN
JOHNSON
OVERTON
FENTRESS
UNION
GRAINGER
WASHINGTON
CARTER
PUTNAM
MORGAN
ANDERSON
JEFFERSON
HAMBLEN
GREENE
UNICOI
DE KALB
WHITE
CUMBERLAND
ROANE
KNOX
SEVIER
COCKE
VAN BUREN
RHEA
LOUDON
BLOUNT
WARREN
BLEDSOE
MEIGS
MONROE
GRUNDY
SEQUATCHIE
McMINN
MARION
HAMILTON
BRADLEY
POLK
Knoxville
Chattanooga
Cleveland
Athens
Dayton
Kingston
Morristown
Greeneville
Jonesboro
Bristol
Blountville
Rogersville
Tazewell
Jacksboro
Clinton
Wartburg
Jamestown
Livingston
Sparta
Spencer
Pikeville
Jasper
Dunlap
Madisonville
Maryville
Sevierville
Newport
Dandridge
Asheville
Rutherfordton
Murphy
Jarretts
Greenville
Dalton
Cohutta
Blue Ridge
Altonpark
GREAT SMOKY MTS.
UNAKA MTS.
BALD MTS.
Abingdon
Marion
Blackey
Longitude West from Greenwich.
10
11
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85°
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through a small area next to the Georgia line, find their way through the Mississippi into the Gulf of Mexico. Of all the streams in the State, the Tennessee and its affluents, the Holston, the Clinch, the French Broad, the Elk and Duck rivers may be considered the main arterial currents and with their tributaries they drain over 40,000 square miles, about 32,000 of which are in the State of Tennessee. The Tennessee River is formed by the junction of the Holston and French Broad rivers, four and one-half miles above Knoxville, Tenn., flows thence southwest into and through northern Alabama and from the northeast corner of Mississippi, nearly due north, entering the Ohio at Paducah, 652 miles from the junction of French Broad and Holston rivers. Its principal tributaries are the Clinch, navigable for 60 miles, the Hiwassee, navigable 41 miles, the Little Tennessee, the Duck and the Elk. The Tennessee is navigable from the junction of the French Broad and Holston rivers to its mouth, except during extreme low water of late summer and fall. Formerly the three main obstructions to navigation at low water were Hale's Bar, 33 miles below Chattanooga, Muscle Shoals, six and one-half miles above Florence, Ala., and the Calbert and Bee Tree Shoals, Riverton, Ala. The Hale's Bar lock and dam, built at a cost of about $11,000,000, dam of solid concrete, 1,200 feet long and about 52 feet average height, lock 60 feet by 267 feet, lift at low water 37.5 feet, forming a pool which gives a depth of 6 feet in front of Chattanooga, 33 miles up the river, was completed and opened to navigation in 1913. This lock and dam was built largely by the Chattanooga and Tennessee Power Company and supplies an enormous amount of electric energy. There is now a lateral canal having a depth of five feet, in two sections, around Muscle Shoals, and a canal with a depth of seven feet around Colbert and Bee Tree Shoals. The river is now navigable the entire year from Riverton to the mouth, 226 miles, for steamboats of three feet draft. There are other shorter sections in which navigation is possible the year round. The traffic on the river in 1914 was 967,528 tons, valued at $21,120,489, consisting principally of general merchandise, livestock, farm products, timber, ore, sand and gravel. The Cumberland River was given its name by a party of Virginians, under Dr. Thomas Walker. They penetrated this section in 1748 and gave the name Cumberland to the river, mountains and gap of that name, in honor of the royal English Duke of Cumberland, then Prime Minister. The Indians called it the Warioto, and the early French traders the Chauvanon (the river of the Shawnees).

The Cumberland River rises in the Cumberland Mountains in Harlan County, southeastern Kentucky, near the Virginia line, and flows thence in a devious great U-shaped course down into Tennessee, curving thence up again into Kentucky, entering into the Ohio near Smithland, Ky., 688 miles from its source. After leaving its mountain sources it flows westerly through the highlands of southeastern Kentucky. Where it cuts its way from the highlands it forms the beautiful Cumberland Falls with a drop of 66 feet. A few miles below these falls it passes over Smith Shoals through a wild gorge, with side walls about 300 feet in height. The scenery along the Cumberland from Carthage, Tenn., to its head is amongst the finest in America. Two hundred and twenty miles of this section, i.e., from Carthage to Burnside, Ky., has good steamboat passenger service for six months of winter and spring. On this navigable stretch may be seen the old Indian town site and the old burial caverns at the mouth of Caney Fork, rugged Sand Shoals, Seven Sisters (a stretch of seven towering cliffs in Clay County, Tenn.), the Natural Bridge near Burksville, Ky., the historic battlefield of Fishing Creek, where the Confederate General, Zollicoffer, lost his life. It is a quaint river. Nearly every one of its beautiful scenic reaches has its legendary story. This portion of the navigable river above Carthage reaches that interesting mountain and highland section, the home of the moonshiners. It is like stepping back into the language, thought and customs of the 18th century.

The Cumberland is navigable from Burnside, Pulaski County, Ky., to its mouth, a distance of 518 miles, for about six months in the year, for boats of three feet draft, and nine months for gasoline boats drawing one foot. From Lock 21 to Burnside, Ky., a distance of about 20 miles, it is navigable the year round. In 1908 the Federal government completed a series of seven locks and dams which rendered the river navigable for the entire year from Nashville, Tenn., to Carthage, Tenn., a distance of 120 miles, and since 1914 has locked and dammed the entire stretch from Nashville to the mouth of the river, a distance of 193 miles. The traffic on Cumberland River for year 1914 was 467,-486 tons, value, $9,023,206. This consisted principally of corn, wheat, livestock, general merchandise, lumber, logs, sand and gravel.

The Mississippi River supplies approximately to the State 200 miles of navigation. The Holston, French Broad, Clinch, Elk and Duck rivers, all tributaries of the Tennessee, are floatable in high tide for logs and flatboats for many miles, though rarely navigable for steamboats. Obey's River and Caney Fork, tributaries of the Cumberland, and the Obion, Forked Deer, the Hatchie, tributaries of the Mississippi River, are navigable for 20 miles or more at high tides. Tennessee has approximately 1,200 miles of navigable waters. See also *Water Power Resources of Tennessee* in this article.

Geology.— Contrary to the popular opinion, all the rocks of Tennessee that show at the surface are of sedimentary origin excepting some in three small areas near the North Carolina line, in the northeastern part of the State, which are of igneous origin. Being of sedimentary origin, they are in layers or beds, and consist of sandstones, conglomerates or pudding stones, limestones, shales, slates, sand and clay. In the Smoky Mountains and the valley of East Tennessee, these beds by the slow but enormous pressure that has been brought to bear upon them from the southeast have had their original horizontal position replaced by great folds that extend in a northeast-southwest direction. Though this pressure was slow, at times and in places it was exerted so fast that the rock beds could not adjust themselves to it by bending, but instead snapped along lines parallel with the folds, thus permitting those beds on the southeast side, little by little, to be shoved up on those of the opposite side. Thus layers that originally were hundreds or in places even thousands of feet apart vertically now rests with their broken edges in contact with each other. Such displacements are known as faults, and there are many of them in the Great Valley of East Tennessee scores of miles long. Indeed some of them run the whole length of the valley, and into the other States at either end. It is this folding and faulting that gives direction to the Great Smoky Mountains themselves, to the valley of East Tennessee and the ridges and minor valleys within it, and to the eastern escarpment of Cumberland Plateau.

The general lay of the rock beds beneath the Cumberland Plateau is that of a syncline or trough, with gradually sloping sides, but this simplicity of structure is broken in the south half by a pronounced arched or anticlinal structure. It is along this arch that Sequatchie River has carved out the valley of the same name.

The general lay of the rocks beneath and bordering the Central Basin is that of an elliptical flat dome with its highest part in the centre of Rutherford County. The direction of the major axis of this dome is northwest-southeast, or roughly parallel with the folds of East Tennessee and the direction of Cumberland Plateau. The sides do not slope uniformly, but are billowy. This dome is the counterpart of a similar one in Kentucky and adjoining territory in southwestern Ohio and southeastern Indiana. In the southeastern corner of Stewart County there is a small structural dome upon which a depression, known as Wells Creek Basin, some two miles wide, has been excavated by the same natural processes that formed the Central Basin. The rock layers on the sides of this dome stand at a much higher angle than those beneath the Central Basin, of which it otherwise is a miniature duplication. The lay of the hard rock beds in West Tennessee, which there are far beneath the surface, is not known, but they probably dip at a low angle to the west, as do the unhardened beds of sand and clay, above them.

The oldest rocks of the State are of Archeozoic Age, and occupy three small areas along the border in Johnson, Carter and Unicoi counties. They include several formations and consist, for the most part, of gneiss, schist and granite. The remainder of the Great Smoky Mountains is composed of rocks of Cambrian Age of which there are several formations. They consist of sandstones, quartzites, conglomerates, limestones, shales and slates. Without the disturbance that has affected the region, these rocks would be overlain in the valley of East Tennessee by the younger Ordovician ones, but the folding, faulting and denudation the area has suffered has in places brought these to the surface in long, narrow belts and smaller irregular patches. Of the Ordovician formations in East Tennessee there are several, the oldest being the upper part of the Knox dolomite, a formation that in places exceeds 3,000 feet in thickness. The lower part is of Cambrian Age. Like the Cambrian rocks, and for the same reason, those of Ordovician Age in the valley of East Tennessee lie for the most part in northeast-southwest belts. Because of the Sequatchie anticline and the erosion upon it, rocks of Ordovician Age are exposed in the floor of the valley as they are in that of the Central Basin, and for the same reasons. Those of East Tennessee are limestone, marble and shale, while those in the Central Basin, which include 12 formations, are nearly all limestone. The Knox dolomite occurs nowhere at the surface in the Central Basin, but owing to greater uplift and probably to reduction in thickness of the overlying formations, it does occur in Wells Creek Basin. Limestone of Silurian Age occurs in narrow belts in the valley of East Tennessee, along the eastern escarpment of Cumberland Plateau, on the western side of the Central Basin, along the streams that flow through the western part of the Highland Rim and along Tennessee River. Black shale of Devonian Age, known as the Chattanooga shale, overlies the Silurian limestone and has the same distribution, except that it occurs in certain places where the former is absent, as on the northern, eastern and southern borders of the Central Basin. The rocks of the Highland Rim and the lower ones of the Cumberland Plateau are of Mississippian Age and consist of chert, shale and limestone. Those of the upper part of the Cumberland Plateau are of Pennsylvanian Age and are composed of shale, sandstone, conglomerate and coal beds.

West of the Tennessee, most of the formations are unconsolidated sand and clay. The lowest and oldest is of Cretaceous Age. Of these there are four formations, which outcrop in north-south belts, within 30 miles of the Tennessee. Westward from the Cretaceous border the surface formations are of Eocene Age, with the exception of the loess and the alluvium bordering the streams. The former, which covers a belt of 30 miles wide next to the Mississippi bluffs, is of Pleistocene Age, and the latter is Recent. The thickness of the Cretaceous and Eocene beds is not known, but a well reported to be 2,000 feet deep on the edge of Reelfoot Lake did not reach through them.

The geological history of Tennessee like that of all other land areas, is one of many changed conditions. At times possibly all of it was land. At others most or all of it was beneath the sea. At still others some parts were above and some beneath the sea. When above, the land was being worn away; when below, the material that forms the rocks was put down in the ocean bed, in layers. There are long periods which are not represented by rocks anywhere in the State and others represented only in part, depending upon whether the State was all land or part land and part water. In Lower Cambrian times, the area probably was all land excepting the part covered by the valley of East Tennessee; in Upper Cambrian, it probably was all sea; in the very long period covered by Ordovician, Silurian, Devonian, Mississippian and Pennsylvanian times, there were many changes that brought more or less of the area, now above the sea, now beneath it. During Triassic and Jurassic and Lower Cretaceous times, the area probably was land. In Upper Cretaceous times, the western third of the State, possibly more, was beneath the sea, as was West Tennessee in Eocene times. Since Eocene times, none of the State has been submerged, excepting possibly the western part for only a relatively short time.

Mineral Resources.— Tennessee is rich in mineral resources. In the order of their importance the 10 leading minerals are coal, copper, zinc, iron, cement, clay, marble, phosphate, limestone and barytes. Coal is mined in the Cumberland Plateau; pig iron is produced in East Tennessee and on the western Highland Rim, in Middle Tennessee; copper, at Ducktown in the southeastern corner of the State; cement, at Richard City and Kingsport; phosphate, in Middle Tennessee; sulphuric acid at Ducktown; brick and tile, in all parts of the State; marble in East Tennessee; gas, coke and the by-products, in East Tennessee; zinc in East Tennessee. Besides these, there are at least 12 others of importance and 20 that are known to occur, though not in commercial amount. There is a large reserve of coal, iron, copper, marble, phosphate rock and zinc. Clay, cement material and many other products of lesser importance, are inexhaustible. Seven million tons of coal are mined yearly. The State produces more copper than all States east of the Rocky Mountains except Michigan. The best ball clay in America is found in inexhaustible quantities in the western portion. One million dollars worth of iron is mined yearly, with one-half billion tons in reserve. Tennessee produces more marble than any State except Vermont or Georgia. One Tennessee plant makes more lime than either North Carolina, South Carolina, Georgia, Florida, Mississippi, Louisiana or Kentucky. There is more phosphate rock in Tennessee than in all States east of the Rocky Mountains together.

Forestry, Fish and Game. *Forestry.*— The forests of Tennessee contain untold wealth in various hardwoods. Prior to 1907 but little attention had been given to this valuable asset. The fifty-fifth general assembly enacted the first general Forestry Law (chap. 397, Acts 1907). This measure received the highest commendation of the Forestry Department at Washington and has proved of inestimable benefit in checking and suppressing forest fires in the State. Under its requirements railroad rights of way were cleaned up and thus ceased to be a constant menace to private property. Prior to 1907 a majority of the forest fires were traceable directly to these railroad rights of way which had grown up in grass and brush liable to be ignited by any passing train. Tennessee is divided into three grand divisions: the western division largely bottom lands, the middle division uplands and the eastern division mountain lands. The rich alluvial lands of the western division produce a heavy timber growth differing from the forests of other sections and consist mainly of oak, cottonwood, hickory and gum. Along some of the water courses in the overflow region are found cypress trees of great value. The upland forest of the middle division consists of mixed hardwoods, largely oak. The best timber has been culled during the process of cultivation of the soil. The tree growth of value is largely to be found in woodlots, the remainder of the land being devoted to agriculture. Large bodies of timber are rare. Great diversity of tree species is found in the eastern division — the mountain region of Tennessee — due largely to differences in elevation, abundant rainfall and different exposures. Three types may be noted: ridge, slope and cove. In the first type is found chestnut, white oak, black oak, black gum short leaf pine and black locust. On some of the high ridges are found balsam and spruce and at lesser elevations black, red and post oak. The slope type consists largely of chestnut, oak, white, black, post oak and hickory. There is also to be found some short leaf pine, sour wood and black gum. The cove type represents the heaviest growth and greatest variety. Topography and soil both favoring. Here is, found yellow poplar, basswood, magnolias and black walnut. In addition chestnut, white oak, beech, sugar maple, hemlock, red oak and hickory, together with a sprinkling of black birch, bitternut, locust, ash, buckeye, sour wood, elm, cherry, sassafras and sycamore. Certain coves contain many of the above species and others few. Forest fires prior to 1907 were very destructive but are not to be compared to those of the Northwest. The necessary brevity of this article leaves much of interest unsaid.

Game.— In the early days Middle Tennessee was termed by the Indians the «Happy Hunting Grounds.» Until some years after the war the whole State was blessed with an abundance of game of many species, deer, bear, wild turkey, grouse and quail. Among the migratory birds, ducks, geese, snipe and plover were found in great numbers during the winter and spring months. By the year 1900, however, conditions had been so changed through the activities of market hunters, «game hogs» and game dealers that it was difficult to find game sufficient to afford any sport. This fact impressed upon conservationists the necessity of some law to prevent extermination. The first general Game Law (chap. 169, Acts 1903) met with violent opposition in the general assembly and passed by a narrow margin. The act to protect non-game birds (chap. 118, Acts 1903) was also passed at this session. The benefits of the Game Law, however, were speedily made so manifest that by 1905 the legislature created the Department of Game, Fish and Forestry (chap. 455, Acts 1905) and added to the law of 1903 many important features (chap. 515, Acts 1905). By 1907 game had greatly increased. A close season on deer was established and several hundred deer in a private park near Nashville were purchased and freed. They soon scattered and under protection have greatly increased. Public sentiment now secured the passage of the first general Fish Law (chap. 489, Acts 1907) and Forestry Law (chap. 397, Acts 1907). Both of these measures had been «side-tracked» in the preceding legislature. In 1909 an attempt was made to legislate the State warden out of office. The Supreme Court declared the measure unconstitutional (14 Cates, 43). In 1915 another like effort was made and again the Supreme Court sustained the incumbent of the office (Howser v. Fullton). Tennessee is cursed with factional politics. Reelfoot Lake, now the property of the State, can be made one of the finest game and fish preserves in the country. It has long been an El Dorado for hunters and fishermen. Public sentiment now strongly favors game and fish laws. It is necessary for their enforcement. Without public sentiment back of it, any law is practically a «dead letter.» With the establishment and operation of the game farm, the outlook for game in Tennessee is encouraging.

Fish.— Few States in the Union have as numerous streams so well adapted for fish as

Tennessee. Many flowing into the rivers are fed by cold springs and are unexcelled for bass, trout, land-locked salmon and perch. Prior to the movement in 1903 for the protection of game and fish, little attention was given this valuable asset. Seining was frequent and dynamiting not uncommon. Little attention was ever paid to local laws. It was not until 1907 that the general Fish Law was passed (chap. 489, Acts 1907). This law was sought to be amended in 1915 (chap. 152, Acts 1915) and the State warden also removed from office. The Supreme Court held this could not be done, but did not pass upon the other features of the bill.

It has been a hard struggle to protect fish in Tennessee. The people have not been educated to the need of their protection. The fine waters, and particularly Reelfoot Lake, should supply fish food in greatest abundance at reasonable cost. The introduction of German carp, like the English sparrow, has been a great misfortune. Eradication of either seems impossible. There has also been a decrease of fish from the pollution of streams. This is a common act, but most uncivilized practice. The agencies at work are too varied for enumeration. The development of manufacturing industries with no restrictions upon disposal of waste is fast ruining many fine streams and the fish have become uneatable from the tainting of the water. The mountain streams of the eastern division, where the population is not sufficient to cause damage by sewage, are often affected by sawdust. Seining, dynamiting and pollution are combining to destroy the fish of the State. Drastic measures must be adopted. It is feasible to keep wastes out of the waters and it is possible to turn them into profit through valuable by-products. A campaign of education as well as law is essential to accomplish the needed results.

Soils.— The soils of the Great Smoky Mountains are mostly rich clays and loams. Those of the valley of East Tennessee are mainly red to brown clay and loam that are very productive, though there are narrow belts derived from certain formations that are poor. Those of the Cumberland Plateau are in parts sandy and in others clayey. The former are not productive and should never be cleared; the latter are not strong, but are susceptible of great improvement. Those of the Highland Rim are in parts fairly good, in others poor, but all can be improved and brought to a high state of cultivation. Those of the Central Basin are very productive clays and loams, and most of the area is in a high state of cultivation. The soils of the western slope vary from those that are sandy and of little worth, through loams and clays that are fairly good and susceptible of great improvement to the rich loess area near the Mississippi, and the rich though narrow alluvial bottoms of the Mississippi, Tennessee and smaller streams.

Agriculture.— The area of Tennessee is 42,022 square miles, or 26,912,000 acres, of which 21,000,000 are farm lands and more than one-half of this is improved.

Principal Crops and Stock.— Diversified farming is general throughout the State, although specialization is practised in some sections. Corn, cotton and wheat are the great staples, leading in importance in the order named. Clover, timothy, soy beans, cow peas, herd's grass, lespedeza, vetch and alfalfa are grown for hay.

The production of strawberries and tomatoes has become one of the paying features, especially in Gibson and adjoining counties. From these and other points vast quantities of vegetables and fruits are shipped to the Northern markets. The entire State offers the conditions necessary to successful fruit culture.

Stock are fed and fattened on a large scale, and this industry is increasing in importance. Hogs are an important product. Poultry raising is extensive, and dairying is generally followed near the larger cities and towns.

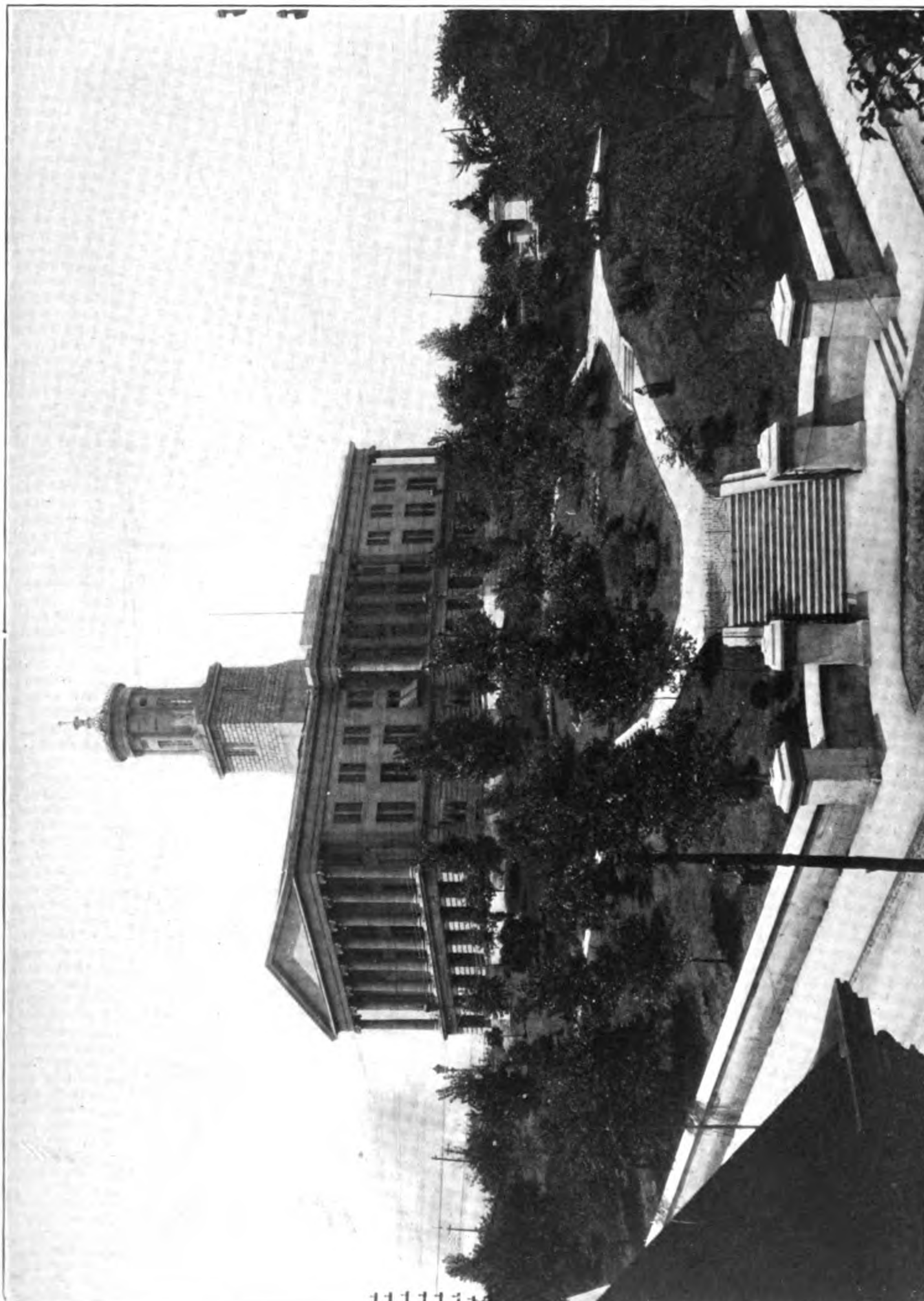
Stock raising in all its branches is generally followed, but this industry is far short of its possibilities. Some advantages the stock raiser enjoys in this State are an agreeable climate, an abundance of excellent food, easily produced, a long outdoor grazing season and a market in which the demand is always in excess of the supply. In short, as a stock-raising country, Tennessee has no superior and but few equals among the States of this Union. The blue-grass section of the State has bred some of the fastest running and the finest harness horses in the world.

Agricultural Department.— The office of commissioner of agriculture of Tennessee was established 14 Dec. 1871. It was then known as the Bureau of Agriculture. W. H. Jackson was elected president and J. B. Killebrew secretary. These men in 1874 issued a comprehensive report of nearly 1,200 pages, with 'The Resources of Tennessee' as its title. The growth of the department has been steady and has become of supreme importance to the State, in view of the fact that of a population of 2,279,000, 80 per cent are farmers and planters who more than ever before have become interested in scientific farming and farming not only as a means of livelihood but as a prosperous business.

The soils of Tennessee are well adapted to diversified farming and respond bountifully to modern methods. In fact, as an all-around crop-producing State Tennessee is not excelled in any other region in the United States in the variety, profusion, character and quality of its farm products. Wonderful possibilities exist in the soils, climate, physical structure and drainage of the agricultural areas. Frequent demonstrations of great crops are reported to the Agricultural Department from each of the three grand divisions of the State, sometimes made on ordinary soils with ordinary cultivations, sometimes on the richest soils with intensive methods applied in the preparation of the land and the cultivation of the crop, exemplifying the versatility and capacity of such lands and the progress of their development.

There are three assistant commissioners of agriculture, who hold office by appointment of the commissioner, and whose work is under his direction. The appropriations by the State to cover the salaries and expenses of the various offices under the commissioner's direction approximate $35,000.

Scientific farming is making rapid strides in Tennessee, and the State's splendid citizenship has become fully awakened to the truism that "co-operation is essential to success." This is



State Capitol at Nashville

fully demonstrated at the farmers' institutes, one great meeting being held annually in each of the three grand divisions of the State — East Tennessee in May, West Tennessee in September and Middle Tennessee in December. It has been truthfully said that there is a "new-born intelligence in even the most secluded rural districts"; farmers who were averse to changing methods of agriculture which have prevailed for ages have awakened to the sense of isolation; they are discarding the old methods and adopting the new. In their homes they are establishing new conditions, making them places not merely of shelter but of comfort and luxury. The tractor and the automobile are rapidly displacing the old-time implements and the buggy. The annual value of farm products approximates $150,000,000; value of domestic animals, $107,000,000; value of all farm property, $614,000,000. It is worthy of note that every crop scheduled in the Federal census is grown to some extent in Tennessee.

Industries.—Although Tennessee has always been, and still is, essentially an agricultural State, the progress it has been making in manufactures strongly indicates marked pre-eminence in industries in the years to come. This pre-eminence would seem to be a necessary corollary to the development of its great natural resources; and it is to be noted that its present progress is along these lines. Approximately $175,000,000 is the capital invested in Tennessee manufacturing generally.

According to the census of 1909 the total number of industries in the State of Tennessee was 4,609, and of these 1,917 were represented by establishments making lumber and timber products. If to these be added the industries that use these products, such as car and carriage factories, approximately one-half of the manufacturing establishments of this State depend upon the natural resources of timber. The inference naturally is that Tennessee is a well-wooded State, and such is the fact. Of the more than 26,000,000 acres in Tennessee, approximately 15,000,000 are woodlands. Three counties have each more than 200,000 acres of virgin forests; and while much of the wooded area of the State is second and third growth, there is still an enormous quantity of virgin trees in the less accessible areas; so much as doubtless to furnish material for the manufacture of lumber and wood products for many years to come. Tennessee has $16,000,000 capital invested in the timber business and 1,500,000 board feet are cut yearly.

In value of products, the flour-mill and grist-mill industry stands but little below that of lumber and timber products. The soil and climatic conditions of the State are conducive to the production of wheat and corn; but this industry does not depend upon local supplies of raw material; for much wheat and corn are shipped into Tennessee mills from the West and the Northwest, and the milling in transit privilege enjoyed for many years by Nashville, Tennessee's largest milling centre, has tended to stimulate this industry and place it upon a permanent and stable basis.

Other manufacturing industries of Tennessee in the order of their importance are: Foundry and machine-shop products; printing and publishing; cars and general shop construction and repairs by steam railroad companies; oil, cottonseed and coke; iron and steel blast furnaces; textiles, and a very large list of other industries aggregating 4,775 establishments in 1914 and covering almost all articles manufactured to meet the ordinary demands of modern life.

The summary of the manufactures of Tennessee for 1914, prepared by the Bureau of Census, gives the following statistics: Number of establishments, 4,775; persons engaged in manufactures, 88,514; proprietors and firm members, 5,142; salaried employees, 8,999; wage-earners (average number employed during the year), 74,373; primary horse power, 286,857; capital, $211,423,000; services, $44,910,000 (including salaries $11,828,000, wages $33,082,000); materials, $123,430,000; value of products, $212,071,000; value added by manufacture (value of products less cost of materials), $88,641,000.

This summary shows a consistent increase in the census report of 1914 as compared with that of 1909. In the order of their importance, from a percentage point of view, the increases for the several items named are as follows: Salaries, 28.8 per cent; capital, 25.9 per cent; materials, 18.7 per cent; primary horse power, 18.4 per cent; value of products, 17.7 per cent; wages, 17.1 per cent; value added by manufacture, 16.3 per cent. It must be borne in mind that the United States census with reference to manufactures excludes hand trades, building trades and neighborhood industries and takes account only of establishments conducted under the factory system. Furthermore, they cover only establishments having annual products valued at more than $500. The four large cities of the State, Nashville, Memphis, Chattanooga and Knoxville, have more than one-fourth of the total establishments of the State. In these cities are most of the very large manufacturing enterprises, such as the following in Nashville: Milling, printing, car-shop construction, stoves and ranges, fertilizer, tobacco and lumber. In Memphis lumber and allied wood-working industries, industries connected with cotton, particularly cottonseed oil mills, molasses mills. In Chattanooga iron and steel manufactures, hosiery mills, knitting mills, wood-working plants. In Knoxville marble enterprises, wood-working establishments, hosiery mills, knitting mills. Speaking generally, the outlook for manufactures in Tennessee is exceedingly encouraging, and it is likely that in the years to come this State will be a very large manufacturing State. This result will be brought about largely by two causes, cheap hydro-electric power and proximity to great natural resources.

Transportation.— Growing out of the agitation for internal improvements about the year 1830, the State undertook with enthusiasm the promotion of railroad development. The South Carolina Railroad, chartered in 1828, the construction of which began in 1829, doubtless furnished an impulse to the movement The desire was for an outlet to some Southern port for the products of agriculture and industry. The first railroad chartered in the State was the Memphis Railroad Company, a proposed line from Memphis to Pulaski, on 12 Dec. 1831. The line was never built. In 1836 the Hiwasse Railroad was chartered and ground broken in 1837, probably the first work ever done on a railroad in the State. This line now forms a part of the Southern Railway between Knoxville and Chattanooga and was completed in

1856. In 1845 the Nashville and Chattanooga Railroad Company was chartered and the track between Nashville and Chattanooga was finished in 1853, the first complete line of railroad operated in the State. In 1845 a great commercial convention was held at Memphis, over which John C. Calhoun presided, out of which grew the Memphis and Charleston Railroad, now a part of the Southern Railway.

The steam railroad mileage of the State for the fiscal year ended 30 June 1914, exclusive of switching and terminal companies, was 4,105.55, or 1.63 per cent of the total mileage of the United States. The State had 9.85 miles of line for each hundred square miles of territory and 18.42 miles of line for each 10,000 inhabitants. In 1870, with 1,492 miles, it ranked 12th in its proportion to the total mileage, In 1914 its standing in this respect was 29th, while as to mileage on the basis of territory it was 28th and on population 38th. Prior to the Constitutional Convention of 1870, the State gave large aid to railroad development and up to the Civil War period, had issued bonds for that purpose amounting to approximately $15,000,000.

For the calendar year 1914 the State levied taxes against 39 railroad corporations, having an assessed value of distributable and localized property of $90,787,256.25, upon which the tax for State purposes alone was $317,755.40. Excluding the special excise taxes of the government, the railroads in the State pay in annual taxes approximately $448 per mile of road. The six railroads of the State operating or controlling more than 50 miles of line, and which embrace about three-fourths of the total mileage, are as follows: Louisville and Nashville Railroad Company, 1,888 miles, including the Nashville, Chattanooga and Saint Louis Railway, with 899 miles; the Southern Railway Company, 985 miles, including the Mobile and Ohio Railroad Company with 119 miles, and the Virginia Southwestern Railway with 101 miles; the Illinois Central Railroad Company with 351 miles; the Tennessee Central Railroad Company, with 294 miles; the Cincinnati, New Orleans and Texas Pacific Railroad Company with 143 miles, and the Carolina, Clinchfield and Ohio Railroad with 55 miles. The freight rates of the State are equitable and the majority of the railroads have a maximum passenger rate of two and a half cents per mile. For the most part, the railroads are assisting to an unusual degree in the development of the resources along their lines.

The street railway mileage in the State in 1914 was 389.9, and had an assessed value for taxation of $14,607,388.89.

The Water-Power Resources of Tennessee. — To state in definite figures the amount of power which can and ultimately will be obtained from the rivers of Tennessee is an impossibility. Any comprehensive scheme of water-power development must, for its realization, ignore political boundaries. For this reason it is not possible to segregate the water-power resources of one State from those of the neighboring States. Furthermore, the quantity of power to be obtained from any given stream is wholly a question of the extent of possible storage of water in reservoirs, the construction of which forms an essential part of the water-power development. This question of reservoirs is itself complex, for it involves questions of vested rights, the agricultural value of lands to be flooded, the relocation of railroads which are already so situated as to render a great many otherwise attractive water-power projects impossible of realization, and other questions of a technical nature no less vital to even an estimate of the amount of power potential in a single river.

Such figures, therefore, as may be presented are to be regarded merely as estimates, and the following table, which has been compiled with great care from all the data available, must be so interpreted.

Summary of the Water Power Available for Development, Without Storage, Wholly Within Tennessee. Minimum Horse Power During the Six High-Water Months.

STREAM	Location	Horse power
Tennessee River	Shellmound to Chattanooga	58,800
Tennessee River	Chattanooga to Knoxville	*50,000
Hiwasse River	From Ocoee River to State Line	69,490
Ocoee River	From mouth to State Line	55,230
Clinch River	From Emory Creek to State Line	35,080
Powell River	From mouth to State Line	8,400
Little River	From mouth to source	4,190
Tellico River	From mouth to source	12,360
Little Tennessee River	From mouth to State Line	87,550
French Broad River	From mouth to State Line	60,000
Citico Creek	From mouth to source	4,000
Abrams Creek	From mouth to source	6,320
Little Pigeon River	From mouth to source	16,360
Nolichucky River and tributaries	From mouth to State Line	67,500
Pigeon River	From mouth to State Line	22,600
Holston River	From mouth to South Fork	56,000
South Fork Holston River	From mouth to State Line	13,500
Watauga River and tributaries	From mouth to State Line	39,800
Small tributaries of Tennessee River		32,340
Tributaries of Cumberland River		74,000
Minor additional streams		15,370
Small water powers not considered by United States Geological Survey †		40,000
Total		828,890
Total available for two-thirds of the time		1,020,000

* The United States Geological Survey ascribes 175,000 horse power to the Tennessee River from Chattanooga to Knoxville; but inasmuch as the interests of navigation would not permit of the development of all of this power, this figure has been reduced to 50,000. According to the report of the chief of engineers of the United States army, 20,000 horse power could economically be developed at a point about six miles from Knoxville.

† J. A. Switzer has estimated the small water powers of the State capable of being developed by individual farmers in units of 25 horse power and less to total 75,000 horse power. (Consult "Resources of Tennessee," Vol. I, No. I). For the purpose of this summary this figure has been reduced to 40,000 horse power.

The total amount of power which a comprehensive plan of development, such for instance as will be necessitated in the future by the exhaustion of cheap coal, will render available is undoubtedly more than double the above figure; quite probably more than triple the figure.

Present Development.— The large developments already completed within the State are comprised in the following table:

COMPANY	Location	River	Installed capacity
Chattanooga and Tennessee River Power Co.	Hales Bar	Tennessee	58,800 horse power
Tennessee Power Co. (two plants)	Parksville and Caney Creek	Ocoee	45,000 horse power
Tennessee Eastern Electric Co	Near Greenville	Nolichucky	16,000 horse power
Watauga Power Co	Near Elizabethton	Watauga	3,200 horse power

The Tennessee Power Company has constructed a third water-power plant, to develop 80,000 horse power, located on Caney Fork, a tributary of the Cumberland River.

Undoubtedly the dominant power interests in the State are those of the Tennessee Power Company. This company, beside owning the three water powers above, leases the plant of the Chattanooga and Tennessee River Power Company at Hales Bar, owns the steam power-plants of the Chattanooga Railway and Light Company, the Nashville Railway and Light Company and a third steam plant at Cleveland. It also holds an undeveloped water-power site, above the two already mentioned, on the Ocoee River. It has the most extensive transmission line in the State. This line connects all of the power-houses with each other and with the cities of Chattanooga, Nashville, Cleveland and Knoxville; and the company has a practical monopoly of the power business in the three first named places and it furnishes power to the Knoxville Railway and Light Company, which supplies the power requirements of Knoxville. Its transmission lines total over 300 miles.

The Tennessee Eastern Electric Company furnishes power to Greenville, Jonesboro and Johnson City; it has steam plants at Greenville and Johnson City and it operates the street car system of the last named place. The Aluminum Company of America, operating under the name of the Knoxville Power Company, has constructed a series of water-power plants on the Little Tennessee River which yield approximately 400,000 horse power. Of these plants, only one is located within Tennessee, the rest being situated in North Carolina, but almost all the power is utilized in the company's reduction works, located at Maryville, Tenn.

State Finances.— 1. *Bonded Indebtedness of the State.*— The status of interest-bearing debt of State up to 1 July 1915 and 1 Oct. 1915 was as follows:

4½ per cent temporary loan refunding bonds, 1 July 1915	$9,381,000
6 per cent temporary loan refunding bonds, 1 Oct. 1915	1,400,000
Short term notes, issued in 1915, 3 per cent interest, 1 July 1915	1,000,000
Total	$11,781,000

July and October 1915, being maturity dates, at which time refunding was due. The above indebtedness was converted into and sold as serial bonds, running 40 years bearing 4 per cent and 4½ per cent interest, averaging 4.28 per cent interest.

Bonds held by charitable and educational institutions:

5 per cent certificates of indebtedness	$14,000
6 per cent certificates of indebtedness	622,000
Total	$636,000

2. *State Tax.*— Both personal property and real estate, 35 cents.

3. *Aggregate assessed valuation of property* in Tennessee for 1913–14 was $560,997,621.

4. *Sinking Fund.*— Upon the adoption of the serial plan of retirement of bonded indebtedness, which of course provides for the semi-annual payment of interest and a portion of the principal, the sinking fund plan was abandoned. The interest payment and proportional payment of principal is stipulated in serial plan or contract, which obligation cannot be postponed by legislation and obviates the necessity of a sinking fund.

Assessment of 1913–14, railroad, telegraph, telephone and street railways:

Railroads	$90,787,256
Telephone and telegraph	6,362,425
Street railways	14,607,388
Increase 1915 combined properties	2,253,000
Total	$114,010,069

The estimated value of property owned by the State in 1883 was $1,579,475; estimated value in 1914, $5,316,378.

Sources of Revenue.— Taxes on polls, on property, on incomes, on sales of land, on exercise of privileges, on litigations, from fines and forfeitures, from merchants, from peddlers and from collateral inheritance tax. All taxes must be uniform.

Exemptions.— One thousand dollars, personal property, each resident taxpayer; United States, State and municipal property not used for rental; religious, charitable, scientific, literary and educational property, subject to certain minor limitations; agricultural and mechanical associations worth less than $10,000; all public thoroughfares and parks dedicated to public use; all growing crops, direct product of the soil.

Banks and Banking.— The following figures largely exhibit the condition of banks in Tennessee in March 1916:

	National	State
Number of banks	107	406
Capital paid in	$14,570,000	$14,216,359 02
Surplus and undivided profits	8,715,000	5,445,373 85
Actual cash	5,004,000	4,126,099 71
Total reserve	18,569,000	26,684,153 41
Deposits	76,035,000	74,712,165 89
Total resources	129,228,000	102,040,044 78

Tennessee has a modern banking law. The State banks are regarded with exceptional confidence by the public. It is optional with the State banks to assume double liability of stockholders. The State under its constitution cannot become the owner in whole or in part of any bank.

Government.—The separation of the powers of government into legislative, executive and judicial departments was specifically recognized in 1776, 1834 and 1870; and the 1796 constitution, also, without mentioning it, so organizes the government. Under the 1776 constitution the legislature elected the governor, who was given no veto power until 1870. Until 1853 the judges of the principal courts were elected by the legislature. Not until after 1834 were the justices of the peace elected by the people. The North Carolina and early Tennessee courts adopted with little hesitation the doctrine of judicial review of legislation. The power of the legislature has been made subject to gradually increasing limitations, both procedural and relating to the variety and scope of its enactments. In 1870 the reaction against the arbitrary acts of the reconstruction governors resulted in a decrease of the powers accorded the governor.

The constitution of Tennessee has reflected its economic and social history. The simple agricultural commonwealths of the 18th century, after securing the people against the encroachments upon their «rights» which had become so frequent under royal governors, demanded only an outline of the frame of government and a few other elementary provisions such as the regulation of the suffrage. The power of the land speculators showed itself clearly in the requirement of a specific land tax in 1796. The enthusiasm for internal improvements was apparent in the constitution of 1834; reaction against its abuse, and against prevalent careless methods of dealing with corporations, in the constitution of 1870. The relative decline of agriculture and the vast increase of mining and manufacturing interests, as well as the trend of population city-ward furnish the economic background for a new convention.

Education.— The public school system controlled by a State board of education; the denominational schools and colleges, the private preparatory schools and the several city systems constitute the means of education. Educational upbuilding has been marked since 1873 which is the time of the beginning of the three chief agencies within the State, namely: (1) The system of public schools, inaugurated by the State legislature; (2) The establishment of George Peabody College for Teachers by the Peabody Board of Trust, and (3) The founding of Vanderbilt University. The general growth of education has been from the eastern boundary of the State toward the west. Of the three grand divisions — East, Middle, West — East Tennessee has had the highest and most general development, while Middle Tennessee is second and West Tennessee the lowest.

Public Schools.—The University of Tennessee is the head of the public school system with all departments located at Knoxville, except the medical and dental colleges which are at Memphis. The department of agriculture maintains, jointly with the United States Department of Agriculture and the State department of agriculture, an extension division which takes to every county experts of every kind needed for farm development. Farm demonstration agents are employed in the counties receiving this service. Support is received from the Morrill Act Fund of 1890; the Nelson Fund, Act of 1907; the Land Grant Fund, Act of 1862; the Hatch Fund, Act of 1887; the Adams Fund, Act of 1906, and from the appropriations of the State legislature — aggregating an annual expenditure of from $350,000 to $400,000. An attendance of 1,000 students is maintained beyond that of the Summer School of the South which annually registers 1,500 attendance. Control of the university is centered in a board of trustees appointed by the governor, one from each Congressional district of the State.

The State board of education has under its direction the normal schools, the high schools and elementary schools through the officers of instruction. This board is appointed by the governor and consists of nine members, with the stipulation that not more than three members shall be from any one grand division of the State. The offices filled by the board are: The State superintendent of public instruction, State high school inspector, presidents of the normal schools, teachers of the normal schools, supervisors of elementary schools, conductors of teachers' institutes and the examiners of teachers' examination papers. Other duties of the board are: Examine teachers under a uniform State law; examine applicants for the position of county superintendent of schools; apportion the school fund as outlined by law; adopt schoolbooks, both elementary and high school; outline all courses of study; certificate all teachers, county superintendents and graduates of the elementary and high schools, and to issue such regulations as may be needed under legal provisions in the general supervision of the public school system.

The school fund is derived from county levies, which vary in amount, and are collected by the county trustees. However, one and one-half mills on the dollar of assessed property are mandatory for all counties through a State enactment. Also, the general education fund established in 1909 provides that 33⅓ per cent of the gross revenues of the State be expended for school purposes, same to be divided as follows: 61 per cent for elementary schools apportioned to the counties on a per capita basis; 10 per cent for county supervisions, consolidated schools, industrial work, salaries of county superintendents; 6 per cent to county high schools; 2 per cent to the Cookeville Polytechnic Institute; 1 per cent to school libraries; 13 per cent to normal schools; 7 per cent to the State University. A poll tax of $2 supplements this fund. The aggregate fund is approximately $8,000,000 — apportioned by the State Board of Education to a school population of 780,000 with 12,000 teachers whose average salary is $50 per month for a term of 130 days. Four normal schools are maintained, one of which is for negroes — with an annual total enrolment of 2,500. Seventy-one counties of 96 have county high schools with an enrolment of 12,500.

The Roman Catholic Church maintains 25 parochial schools, with 4,170 pupils, one college for boys with 350 students, five academies for girls with 619 pupils, two orphan asylums with 325 orphans, making a total of 5,464 young people now under Catholic care out of a Catholic population of 19,000.

Private Schools.— The famous Webb School at Bellbuckle is the pioneer of college preparatory schools in the territory southwest of the river Ohio. Others of the same type whose special purpose is to train boys for college are Branham and Hughes School at Spring Hill; Morgan School at Fayetteville; Hawkins School, Gallatin; Castle Heights, Lebanon; Battle Ground Academy, Franklin; McTyeire School, McKenzie; McFerrin School, Martin; Massey School, Pulaski; Peoples-Tucker School, Springfield; Montgomery Bell Academy, Nashville; Duncan School, Nashville; Bowen School, Nashville; Wallace School, Nashville; Baylor School, Chattanooga; McCallie School, Chattanooga; Columbia Military Academy; University School, Memphis; Sewanee Military Academy; Industrial School, Huntingdon.

Higher Institutions.— The following colleges are strongly supported and enjoying prosperous administrations: Vanderbilt University, Nashville; George Peabody College for Teachers (General Education Board), Nashville; University of Chattanooga (Methodist); Carson-Newman College, Jefferson City (Baptist); Milligan College (Disciple), Tusculum, (Presbyterian), Greeneville; Washington College (Presbyterian); University of Tennessee, Knoxville (State); Cumberland University, Lebanon (Presbyterian); Southwestern Presbyterian University, Clarksville (Presbyterian); Union University, Jackson (Baptist); Tennessee College, Murfreesboro (Baptist); University of the South, Sewanee (Episcopal); Maryville College, Maryville (Presbyterian); College of the Christian Brothers, Memphis (R. C.); Saint Cecilia's Academy, Nashville (R C.); Sacred Heart Institute, Memphis (R. C.).

Junior Colleges.— Several institutions have organized regular junior college curricula as follows: Ward-Belmont, Nashville; Buford College, Nashville; Martin College, Pulaski; Hiawassee College, Madisonville, and the State normal schools at Murfreesboro, Johnson City and Memphis.

Higher Institutions for Negroes.— The highest standards of efficiency are attained in the colored institutions which take their place alongside similar schools for the white race. Fisk University, Nashville (Congregational); Roger Williams, Nashville (Baptist); Walden University, Nashville (Methodist); Lane College, Jackson (Methodist); Knoxville College; Turner College, Shelbyville; Industrial Normal School, Nashville (State); Academy and Industrial School of the Immaculate Mother, Nashville (R. C.).

Charitable Institutions.— The following institutions receive their support from the State: The Central Hospital for Insane located near Nashville; the Western Hospital for Insane located at Boliver; the Eastern Hospital for Insane located at Bearden; the Reformatory for Boys located near Nashville; the Tennessee Industrial School located near Nashville; the Tennessee Confederate Soldiers' Home at Hermitage; three of the larger counties in Tennessee have their own industrial schools, namely, Shelby, Knox and Hamilton.

Throughout the State are a great many institutions which derive their support through voluntary contributions from individuals, or through societies organized for that purpose, such as the Masonic Home located near Nashville, the Odd Fellows Home at Clarksville and the Old Woman's Home at Nashville. Many counties in the State maintain charity institutions such as county asylums, poorhouses. The State has also in the past given aid to private institutions such as the Tennessee Children's Home, Finding Society and the School for Blind Girls.

Penal Institutions.— Penal institutions are the penitentiary, or State prison, to which persons convicted of felonies are sentenced; and county jails used for the detention of persons awaiting trial, or those who have been convicted of felony and are temporarily held until they may be conveyed to the penitentiary. Sentences for terms less than one year are to the county jail, and persons fined by the criminal courts and failing to pay such fines are also imprisoned therein. Under the law a county jail may be declared to be a workhouse, in which case the prisoners may be worked on the highways during the term of their sentences, or until their fines shall be paid according to a schedule of valuation placed upon their labor. The cities also have workhouses for the punishment of infractions of city ordinances authorized by State law. Workhouse prisoners may be transferred from one county to another, and hence the labor of prisoners from several counties may be applied to highways in one county together, an arrangement due to the fact that in most counties there are very few county prisoners.

The penitentiary, or State prison, was established under an act passed in 1829, and began to receive prisoners in 1831. It was conducted under the direct management of the State until 1870, except when held by the United States military forces from 1862 to 1865, and except when under an abortive lease in 1867–68. From 1870 to 1897 the lease system was in force, although the State at the same time employed a superintendent, wardens and physicians, to look after the interests of the prisoners and State, as well as could be done under the system.

The act of 1893 provided for a change to the State account system, with a provision permitting the hiring out of a part of the convicts at the main prison under contracts for labor by the day; also for the purchase of farm and coal lands. A farm of 1,100 acres, lying in a large bend of the river six miles below Nashville, was bought and a commodious modern prison was erected thereon. Later 2,400 acres were added to this prison farm. For coal mining purposes the State purchased the Brushy Mountain tract of 12,000 acres in Morgan and Anderson counties, and later purchased «Herbert Domain» of 10,000 acres in Bledsoe and partly in Cumberland, White and Van Buren counties. This latter tract is supposed to contain good coal, but it has not been opened. In the same act the State is forbidden to mine by convict labor except in the State's mine. A large number of convicts are employed at Brushy Mountain, the number on 1 Dec. 1914 being 616, while those in the main prison at the same time were 1,243; total, 1,859. White convicts were 651, colored 1,208. Females 62, all at Nashville.

At the main prison two-thirds of the convicts are employed in manufacture, blacksmithing, farming, clerical and domestic work, etc., under direct management; one-third are similarly employed under contracts with outside parties, but all are kept under the eye of trusted State officials to see that the humane provisions of the law are carried out.

During 1915–16 200 convicts were hired to Campbell County, and 50 to Williamson, and employed in working on public roads at 10 cents an hour. This new departure seems to be successful; there is a strong movement so to employ the mass of the convicts in the future. The Indeterminate Sentence Law is in force.

In 1915 an act was passed creating the Board of Control, with its office at Nashville, whereby the several public institutions of the State, as the penitentiary, State Reformatory, Tennessee Industrial School, asylums for the insane, deaf, dumb and blind schools, are brought under one board for their better and more uniform management. The statistics of the operations of this board have not been issued for 1915–16.

For a number of years following 1897, when the new system for the prison went into effect, profits over expenses were large, often running over $200,000 net profits a year, but in more recent years the receipts have not much exceeded expenses.

While the convicts were employed under the lease system and many of them confined in the old prison which was, from 1887 to 1897, within the city limits of Nashville, the death rate was high, being at times over 3 per cent; the report to the end of 1914 shows a death rate of 9.3 per cent.

There are two institutions which are semi-penal in character, the Tennessee Reformatory for Boys and the Tennessee Industrial School. The reformatory is in a different part of Davidson County from the main prison, but is in a way connected with it, and to it are committed young convicts with a view to reformation and schooling. The judges of the Criminal Courts may send any convict under 18 years of age to this reformatory, and nearly all such are so disposed of. The population of the reformatory is 497.

The industrial school is designed for the care of young persons who are without the care of guardians or provident parents and such as are found wandering or loitering in company of evil repute. The pupils or inmates of the industrial school number 860. Several different counties maintain institutions of the same kind, and they are recognized by the courts. The discipline is of great value, and there are many pupils who have not been placed in the school by reason of any complaint against them.

The act of 1911 establishes the Juvenile Court and divides young offenders and unfortunates into two main classes, namely, delinquent and dependent. Delinquents are those who have committed some penal offense, while dependents are such as have been mentioned herein in connection with the industrial school. The heads of the Juvenile Courts in the largest cities are the city judges, but in nearly all the counties this position is assigned to the judge or chairman of the County Court. No person under the age of 16 years can now be tried and sentenced, in the first instance, to the penitentiary, jail or workhouse, it being the duty of the judge of the Criminal Court whenever a person of such age is indicted to turn such youth over to the Juvenile Court. The Juvenile Court shall send him to the reformatory, industrial school or other institution of the kind, or may commit him to the care of a guardian, for a definite period; and shall retain supervision until the youth shall be of age. The person accused has free legal counsel, and his parents may defend for him. If the youth prove totally intractable, after due effort at reformation, he may be tried later as any other criminal and sentenced to prison. By the act of 1915 capital punishment was abolished.

Archæology. *Eolithic and palæolithic Man.* —When and from whence primitive man first came into the section now known as Tennessee is still undecided. It is claimed, and also denied, that remains of man of same geological age and culture as that of the earliest and rudest of eolithic and palæolithic man of Europe have been found in several sections of the United States, but no well-authenticated finds of such have been made in Tennessee. If eolithic or palæolithic man ever existed on this continent, the caverns and rock-shelters of the Cumberland and Tennessee valleys offered ideal places for their abodes. These were about the right distance below the great ice fields — which reached to the Ohio River, at or near the end of the last great Ice Age — to offer practically the same climate and shelter in which eolithic and palæolithic man were found in Europe.

The Mound Builders.— Formerly it was believed that the ancient mounds and fortifications of this section were built by a long-vanished people, of lighter complexion and different race from the Indians. This belief originated from some of the early Indians telling the whites that the Indians did not build the mounds, but they were built by an earlier white race, who lived here before the Indians came, and the Indians conquered and exterminated them. Modern research has proved this to be untrue. It is now well established that these great earthworks were built by Indians.

The contents of these mounds show them to have been erected by men of the same habits of life, same degree of barbarism, same religious customs as the Indians found here by the first whites. In fact many of these mounds contain articles of European make, which the Indians had obtained from the whites. DeSoto in 1540 found the southern Indians using these mounds for sites for their religious houses, and for the residences of their chief men.

Scattered along the larger water courses of Tennessee are probably over 100 of these ancient mounds. Each mound is usually accompanied by a village site and hundreds of ancient graves. These remains are of widely different ages and show somewhat different artifacts and customs. It is probably true that there are as many ancient Indian graves in Tennessee as there are white graves. The ancient population of Tennessee was probably never, at any one time, over 20,000; but Indians have roved over this section, changing town sites in some instances, for several thousand years, giving rise to the many remains of widely different ages.

Principal Indian Tribes.— At the time the whites first visited this section Cherokees, Shawnees and Chickasaws were the principal tribes inhabiting Tennessee.

The Cherokees.— The Cherokees were a strong separate tribe of the Iroquoian stock. They at one time held the entire southern Allegheny region in southwestern Virginia, western North Carolina, west-South Carolina, northern Georgia, northeastern Alabama and East Tennessee. De Soto found them in this section as early as 1540 and they probably had been here long before. The Cherokees also claimed all the land between Tennessee and the Cumberland River and on to the Ohio River, but had few or no towns in that region. The Cherokees aided by the Chickasaws drove the Shawnees from the region around Nashville, about the year 1710. The Shawnees gradually moved north of the Ohio. The feud between the Cherokees and the Shawnees continuing, both parties ceased to hunt or live to any large extent in the disputed territory in Middle Tennessee. So, for nearly 60 years after 1710, this fertile section was unoccupied and became full of game. The whites were attracted by the game, rich soil and comparative freedom from Indians, and began settlements under General Robertson, at what is now Nashville, about 1779. The Cherokees were gradually forced to give up their lands and emigrate to Texas and the Indian Territory, while a few remained in the mountains of western North Carolina, and 1,376 are now living on Qualla Reservation in Swain County, N. C., and 300 on Cheowah Reservation in Graham County, N. C.

The Shawnees.— The Shawnees have a most interesting history. They originally came from the north and were of Algonquian stock. In the year 1669 when we first begin to have any authentic history of them, we find a part of the tribe living in the Cumberland Valley in Middle Tennessee, and ranging from the Tennessee River on the south to the Kentucky River on the north. One of their principal towns was on the present site of Nashville; another, and earlier one, at what is now Castalian Springs, in Summer County, Tenn. The Shawnees at this time were living in friendship with the Cherokees, and it is claimed by the Cherokees that the Shawnees were occupying this territory by their permission. About 1707 war arose between the Shawnees and the more powerful Cherokees. In consequence small bodies of Shawnees were continually leaving and seeking their friends and kindred north of the Ohio River. The last of the Shawnees left in the Cumberland Valley attempted to leave their home at Nashville, and join their brethren in the north about 1710. These were ambushed by the Cherokees and their allies — the Chickasaws — on Cumberland River just above the mouth of the Harpeth, and practically all this body of Shawnees were slain. Some of the Shawnees from the Cumberland, after living for a time in Kentucky, formed a settlement at Shawneetown, Ill. About 1730 these removed to Ohio and joined other Shawnees. About 1750 these western Shawnees were joined by the eastern branch of the tribe. This eastern branch had originated in the north, later emigrated to the headwaters of the Santee and Peedee rivers in South Carolina. Gradually driven thence by the warlike Catawbas, during the period 1690 to 1720, they drifted north, building the old Shawnee towns of Winchester, Va., and Oldtown, Md., on their way. They finally established themselves in Lancaster County, Pa. They made a treaty with William Penn in 1701. It is said they had a copy of this treaty 50 years later. The eastern and western branches of the tribe having joined in Ohio, they became the allies of the French, and for nearly 40 years were constantly at war with the English, or the citizens of the newly-formed United States. Many of the expeditions sent to the country north of the Ohio during the War of the Revolution were against the Shawnees, and most of the bloody work in northern Kentucky was done by the Shawnees. When peace had been declared after the War of Revolution a considerable body accepted the invitation of the Spanish government to settle near Cape Girardeau, Mo., in what was then Spanish territory. Another party of Shawnees settled on White River in Indiana. From this last section of the tribe sprang the great Tecumseh and his twin brother, Tenskwatawa, the Prophet. The Prophet was defeated by Harrison at the battle of Tippecanoe in 1811. The warlike spirit of the Shawnees was broken by this overwhelming defeat. About 1825 the various sections of the tribe began moving west to a reservation in Kansas. About 1845 a large part of the Kansas section moved to the Canadian River country of the Indian Territory.

Military History.— Tennessee is designated the «Volunteer» State — a name acquired in the war with Mexico. Her military history begins at King's Mountain during the Revolution. Creasy in his 'Fifteen Decisive Battles of the World,' says the battle of Saratoga is the decisive one in our Revolutionary struggle; if that is so, King's Mountain is second in importance to that engagement alone.

This battle was fought on 25 Sept. 1780. The force was under the command of Cols. John Sevier, Isaac Shelby and William Campbell, and composed entirely of East Tennessee mountaineers, who rendezvoused at Sycamore Falls on the Watauga River, several days before their departure to intercept the British forces under the command of Col. Patrick Ferguson, who was advancing from the Carolinas to join the army of Lord Cornwallis in Virginia. The victory of the Tennesseans was complete. Ferguson was killed and his whole army either killed or captured. His sword and sash are among the relics in the Tennessee Historical Society at Nashville, also the gun with which he was killed. This battle prevented the junction of the two British forces and hastened the surrender of Cornwallis to General Washington at Yorktown, which ended the war and gave us our independence.

Tennessee became a State in 1796. Since

that date it has taken an active and leading part in all the wars in which the country has been engaged. In the War of 1812 she furnished 28,000 troops and had double the number of any other State in the battle of New Orleans, fought by General Jackson — one of her sons — on the 8 Jan. 1815, in which the British commander, General Packenham, was killed. In the several Indian wars east of the Mississippi — in the States of Florida, Georgia, Alabama and Tennessee — she furnished nearly all of the soldiers engaged, as well as the commanding officers — Jackson, Houston, Coffee and Carroll. The happy ending of these wars gave peace and security to life and property to the people of these States against the torch, tomahawk and scalping knife of the cruel, treacherous and relentless savage.

The principal battles in these Indian wars were Tallahatchee, Tuscaloosa, Emuckfau, Erotochapco, on the Tallapoosa River, and the decisive battle of the Horseshoe, which ended the Creek War — their noted chief and leader, Red Eagle, being captured.

The next link in her military history is the part she took in the Mexican War of the 40's. Under proclamation of President Polk, Gov. Aaron V. Brown called for the enlistment of 2,800 troops. The number of 30,000 immediately responded, which gave gave to her the title of the «Volunteer» State. Two regiments of infantry were accepted, the First Tennessee, under Col. William B. Campbell, and the Second, under Col. William T. Haskell, together with several cavalry companies. She furnished one major-general, Gideon J. Pillow. The principal battles in which her troops took part were Cerro Gordo, Cherubusco, Molino del Rey and Chepultepec, entering the city of Mexico under the command of Gen. Winfield Scott. During our Civil War Tennessee was one of the principal battle grounds, Virginia being the other. Her geographical limits and location between the two contending sections — extending rhomboidal in shape — nearly 500 miles, from the Great Smoky range on the east to the Mississippi River on the west — necessarily made her soil the theatre of action of the two hostile armies and for numerous raids and engagements of cavalry and mounted infantry of both sections. The result was there were 454 engagements or affairs-at-arms within her borders, more than in any other State, during her fighting period, from 12 Dec. 1861, when the first clash of arms occurred at Morristown in East Tennessee, till the last engagement on 12 June 1865 at Plum Butte.

These affairs-at-arms include such conflicts as the battles of Forts Henry and Donelson — the former on the Tennessee, the latter on the Cumberland — Shiloh, Murfreesboro, Fort Pillow, Island Ten, the naval battle at Memphis, the two battles of Missionary Ridge, the closing scenes of Chickamauga and the battles of Franklin and Nashville in December 1864.

Her regiments of infantry reached the number of 84. The total number of troops furnished to both armies were 145,000, 30,000 of which were in the Union army. She had 27 regiments, 15 battalions and 84 miscellaneous companies of cavalry, making a total of 126 cavalry commands and 28 companies of light or field artillery; thus showing that Tennessee furnished more soldiers during our Civil War than any other Southern State, North Carolina furnishing a few thousand more to the armies of the South than she did.

She had in active service 1 lieutenant-general, 9 major-generals, 33 brigadier-generals and 153 colonels, with lieutenant-colonels and majors in proportion. She had nine general officers killed in battle — to wit: Zollicoffer, Hatton, Smith, Tyler, Strahl, Carter, McCulloch, Adams and Rains.

The semi-military organizations of bivouacs and chapters had their origin in Nashville. The celebrated Ku Klux-Klan (q.v.), which worked for peace and security, not only for her own people, but for the entire South, also originated in one of her towns — Pulaski — in the county of Giles.

To show to what extent Tennessee was the theatre of active hostilities from 1861 to 1865, the general government maintains seven cemeteries in the State, in which 42,000 Federal soldiers are buried.

In the War with Germany in 1917–18 the State's gross quota was placed at 22,158; enlistment credits totaled 7,592; total enlistments, 11,899; the net quota, 14,528. The total number of registrants under the Selective Service Law was 188,946, of whom 54,827 were called for examination. Of these 15,909 were accepted, making the ratio to those called for examination 29.02 per cent. There were 34,069 colored registrants, of whom 7,940 were called for examination and 2,866 were accepted. The aliens from Entente countries, who registered, numbered 794; 73 were from neutral states; 44 were alien enemies.

State Formation.— The State of Tennessee was formed out of the western half of North Carolina. The first white men of whom we have any account to set foot on Tennessee soil were De Soto and his band of adventurers, in 1541. In 1662 La Salle built a fort which he called Prudhomme, where Memphis now stands. Fort Loudon on the Little Tennessee River, 30 miles below Knoxville, was built and occupied by the British in 1756. In 1760 it was surrendered to the Indians on condition that the troops and their families should be allowed to return to the Eastern settlements, but most of them were treacherously massacred the morning after leaving the fort. In 1769 Capt. Wm. Bean and his family built a cabin at the mouth of Boon's Creek. His son Russell was probably the first white child to be born in Tennessee. Within a few months a number of families from eastern North Carolina and Virginia located in the same vicinity. It was called The Watauga Settlement. In 1771 Parker and Carter set up a store to trade with the Indians where Rogersville now is. This was called The Carter Settlement. The next year Jacob Brown established a store on the Nollichucky River. In a short time many settlers built cabins around these stores. Another settlement was made on the Holston River, which soon became an important centre. These pioneers being far from the mother State, without government and without protection, in 1772 organized themselves into the Watauga Association, the purpose of which was to protect themselves and to dispense justice among the colonists. The leaders were John Sevier and James Robertson. The Watauga Association was the foundation of the Commonwealth of Tennessee. Roosevelt says that these were the first white men of America to establish a free and independent community on the continent. In the Spring of 1776 Nancy Ward — a friendly Indian woman — informed the whites that 700 Indian warriors who had been supplied by the British with arms and ammunition for the purpose, under Dragging Canoe and Old Abraham, were preparing to attack Heaton's and the Watauga forts and destroy the settlers. The Indians were defeated in two battles. The settlers, when the Revolutionary War began, named their country Washington District and voted themselves indebted to the United Colonies for their share of the general expenses of the war.[s] In August 1776 113 of the pioneers signed a petition to be annexed to North Carolina. All but two of these signed with their own hands. Two made their «marks.» In November following four delegates from Washington District were sent to the Provincial Congress of North Carolina. In 1777 Washington District became Washington County and embraced all of what is now Tennessee. The battle of King's Mountain 3 Oct. 1780, which has been termed the turning point in the Revolutionary War, was chiefly won by the Tennessee patriots under John Sevier and Isaac Shelby. In 1784 North Carolina ceded to the United States that part of her territory which is embraced by the present State of Tennessee and gave Congress one year in which to accept or reject the grant. No arrangements satisfactory to the frontiersmen were made for a government, which caused great dissatisfaction among the people who decided to set up a government of their own. At this time there were three counties, Washington, Sullivan and Greene. Each county selected delegates who met at Jonesborough, the oldest town in the Territory August 1784 and elected John Sevier president, and Landon Carter secretary. The convention resolved to form a new State and provided for another convention to form a constitution and start the new government. Instead of a new constitution the convention adopted that of North Carolina. The new State was given the name Franklin. Sevier was elected governor and all other officers, civil and military, were elected. The governor of North Carolina issued his proclamation ordering the people to disband and return to their allegiance to the mother State. The people were divided, some favoring Franklin and others North Carolina. This division in public sentiment engendered much bad feeling and strife. Sevier tried to persuade North Carolina to agree to the independence of Franklin and to have Congress recognize it, but failed in both. In 1788 Sevier was arrested and Franklin collapsed. A general pardon was granted to the disaffected people. Sevier was elected to the senate of North Carolina and was restored to his former office of brigadier-general of Washington District.

A party of men called «the long hunters» explored Middle Tennessee — the Cumberlanc country — in 1778. They made a clearing at Bledsoe's Lick and planted corn the following year. In 1779 James Robertson, called «the Father of Middle Tennessee,» with a number of others, settled where Nashville now is. Their families came by water, down the Holston, the Tennessee, up the Ohio and the Cumberland, a distance of a thousand miles the next spring. Several other settlements were made the same year. On 13 May 1780 each settlement sent representatives to Nashborough where a compact of government was entered into and signed by 256 men, only one of whom was unable to sign his name. James Robertson was chosen chairman and was practically the governor of the new settlements. In 1783 the Cumberland settlements were organized into Davidson County, N. C. The county embraced all of Middle Tennessee north of Duck River. A court was established. Nashborough was changed to Nashville and was made the seat of government for the county in 1784. At that time Spain claimed Alabama, Mississippi, Tennessee and western Kentucky and closed the Mississippi River to the commerce of the settlers whom the Spanish treated as intruders. The Spanish supplied the Indians with arms and ammunition and incited them to acts of hostility against the whites. From the summer of 1780 to 1794 the frontier people were in constant danger, many of them, men, women and children, being killed and much property destroyed or stolen. After the cession by North Carolina and its acceptance by Congress in 1790, Robertson was made brigadier-general of the district. Governor Blount was ordered by the President to permit no attacks on the Indians. The Spanish became angered and refused to complete a treaty for the free navigation of the Mississippi. Robertson learned that the Spanish traders were buying American scalps from the Indians and were instigating raids on his people. His brother, his son and many others were killed and others wounded. These last acts so incensed the whites that Robertson ordered an attack on the Cherokee towns below Chattanooga. Five towns were destroyed and many Indians killed. Then came peace for the pioneers. The Secretary of War severely condemned this act of just retribution, which injustice so incensed the people in the West that many of them favored setting up a separate government, or casting their lot with Spain. One of the first acts of North Carolina, after becoming a State of the Union, was to make to Congress a second cession of her western territory. This was on 25 Feb. 1790. The cession was accepted on 2 April. On 8 June President Washington commissioned William Blount governor of the Territory belonging to the United States south of the river Ohio. In 1775 an enumeration disclosed the fact that there were more than 60,000 inhabitants in the Territory. A constitutional convention was called and completed its labors 6 February and the people asked to be admitted into the Union as a State. The act admitting Tennessee was approved by Washington on 1 June 1796.

Constitutional History.— Tennessee as already stated was originally the Western Territory recognized as belonging to North Carolina and, during its early settlement, lived under the nominal jurisdiction of that province and later of that State, whose political institutions it was to inherit. In several instances temporary compacts were drawn up by isolated communities until the jurisdiction of North

Carolina could in fact be extended to them. The insurrectionary state of Franklin adopted the constitution which North Carolina had framed on declaring its independence in 1776. After the cession of North Carolina's western possessions to the United States, the organic law of the land was the act of Congress for the government of the Territory Northwest of the River Ohio, made applicable to the Southwest Territory by a separate act.

With this experience in constitution-making and having before them the newly-adopted Constitution of the United States, the people of Tennessee sent their representatives to a convention at Knoxville in 1796 to form the constitution under which they were to live as a State of the Union so soon as Congress should recognize their demand for Statehood. Like the North Carolina constitution, it was adopted in committee and not submitted to popular vote. William Blount, governor of the Southwest Territory, was president of the convention and Andrew Jackson, a prominent member, is said to have suggested that the name of the new State should be Tennessee.

The constitution of 1796 remained unchanged until 1834 when another convention, with William B. Carter as chairman, met in response to a genuine popular demand for alterations that would bring the constitution in accord with growth of the State and the spirit of the times. A new instrument was drawn up and submitted for adoption to the electorate as established by it.

Amendments were adopted in 1853 and 1865 and in 1869 a convention to meet the following year was called by the legislature. John C. Brown was made president by the convention. In 1897 a proposal by the legislature to hold another election was disapproved by the voters and in 1904 a number of amendments submitted by the legislature were likewise rejected.

Aside from the inevitable constitutional evolution through court decisions, legislative and administrative action and the changing conceptions of the people, the rapidly changing political and social life of the last generation has met with no constitutional response. Previous to the Civil War, however, the naturally gradual development of the Tennessee constitution corresponded with the growth of State constitutions generally. In length and complexity it advanced from the less than 5,000-word instrument adopted by North Carolina in 1776 to the 14,000-word constitution of 1870. The North Carolina constitution placed property qualifications on both voting and office-holding. In 1796 what amounted to manhood suffrage was established for freemen. The 1834 constitution omitted all property qualifications but disfranchised free negroes. The 1870 constitution contains much added detail, but few changes of general importance. The 18th century declarations of the rights of individuals have continued almost unchanged to the present.

Civil and Political History.— During the early years of Statehood the two problems of chief importance were the danger from the Indians and the settlement of land titles. The two early centres of Tennessee were far apart, divided by rough mountainous country. It was many years before one could journey from Knoxville to Nashville without crossing land in the possession of Indian tribes. Strip by strip was bought from the Indians by the United States government. The region between the Tennessee and the Mississippi rivers known as "the Western District" was not open to white settlement until 1818; the last lands held by the Cherokees, constituting the southeastern corner of the State, were not purchased until the treaty of New Echota.

Land titles were derived from North Carolina. Ownership was acquired through military warrants by which the State undertook to pay its soldiers in land, or by purchase, through which means much of the North Carolina paper currency was redeemed. Liberal rights of preemption were given to squatters. Upon the cession of the Tennessee country to the United States, and the later erection of the State of Tennessee, there arose a long and complicated dispute to which North Carolina, Tennessee and the United States government were parties. This matter of the public lands gravely affected the development of public support of education, internal improvement and banking. In the earlier period speculation in land also was a noteworthy factor.

For many years John Sevier was the most prominent figure in the State's life. His influence was identified with East Tennessee, the oldest section of the State. As the middle and western parts were settled, Indian wars and national affairs brought into prominence the personality of Andrew Jackson, but when Jackson became President resentment against some of his actions and against his efforts to continue domination over Tennessee politics led to the rise of a vigorous Whig party, which usually prevailed in national elections. From 1835 to 1855 Tennessee was a bitterly contested State. Its relatively large population and the closeness of its vote gave it a prominence in national politics. Hugh Lawson White, John Bell, Andrew J. Donelson were nominees for the Presidency or Vice-Presidency who were unsuccessful. James K. Polk was elected President in 1844, and Andrew Johnson Vice-President in 1864. The prominence of these, and a host of other men, was due to the fact that Tennessee in this period constituted a type and was a true representative of the West.

Within the State, matters of internal improvement, especially railroads, banking, education, were prominent in political discussion. The State was almost entirely agricultural, the population of the towns being relatively very small. Slavery existed all over the State. In East Tennessee, however, there arose a decided anti-slavery movement which ran its course when the most active opponents of the system emigrated from the State. Physical differences left a positive stamp upon the attitude of the different parts of the State toward slavery. East Tennessee had relatively few slaves: the western district, on the contrary, developed like Mississippi. Sentiment in the State was conservative and devoted to the Union. Secession was refused by popular vote until after Lincoln's call for troops; then a fever of sympathy with the States of the South swept over Tennessee with the exception of the eastern region where Andrew Johnson and William G. ("Parson") Brownlow, always hitherto the bitterest political enemies, now joined in support of the Union. The course of military events soon led to the domination of East Tennessee, strongly Unionist in sympathy, by Confederate forces who kept open the line of communication from the Southwest to Richmond, while the Federal successes at Fort Pillow and Fort Donelson threw Middle and West Tennessee into the possession of the Federal authorities under whom Andrew Johnson was appointed governor. The régime of Unionist East Tennessee was perpetuated after the war in the administration of Governor Brownlow, which was characterized by enormous additions to the State debt and by rigorous repression of those formerly in control of the political affairs of the State. This state of affairs did not come to an end until 1870, when the Democratic party again came into control. Since then Republican East Tennessee has been dominated by the Democratic remainder of the State, except when some particular question such as the settlement of the State debt or the establishment of State-wide prohibition have divided the Democratic party and brought about the election of a Republican governor. In politics, in recent years, the prohibition question has had first place, and other matters have not received due attention. The constitution has not been amended since 1870. A notable advance was made, however, in the field of public education with the establishment of a system of county high schools and State normal schools.

LIST OF GOVERNORS.

William Blount	Territorial governor till	1796
John Sevier	Democratic-Republican	1796–1801
Archibald Roan	" "	1801–03
John Sevier	" "	1803–09
Willie Blount	" "	1809–15
Joseph McMinn	" "	1815–21
William Carroll	" "	1821–27
Sam Houston	" "	1827–29
William Hall (acting)		1829
William Carroll	Democrat	1829–35
Newton Cannon	States-Rights Democrat	1836–39
James K. Polk	Democrat	1839–41
James C. Jones	Whig	1841–45
Aaron V. Brown	Democrat	1845–47
Neil S. Brown	Whig	1847–49
William Trousdale	Democrat	1849–51
William B. Campbell	Whig	1851–53
Andrew Johnson	Democrat	1853–57
Isham G. Harris	"	1857–62
Andrew Johnson	Military	1862–65
Interregnum	4th March, 5th April	1865
William G. Brownlow	Republican	1865–69
DeWitt C. Senter	Conservative-Republican	1869–71
John C. Brown	Democrat	1871–75
James D. Porter	"	1875–79
Albert S. Marks	"	1879–81
Alvin Hawkins	Republican	1881–83
William B. Bate	Democrat	1883–87
Robert L. Taylor	"	1887–91
John P. Buchanan	"	1891–93
Peter Turney	"	1893–97
Robert L. Taylor	"	1897–99
Benton McMillin	"	1899–1903
James B. Frazier	"	1903–05
John B. Cox	"	1905–07
Malcolm R. Patterson	"	1907–11
Ben W. Hooper	Republican	1911–15
Thomas C. Rye	Democrat	1915–19

Population.— Tennessee has a population of 2,184,789 (census 1910). The government figures show that of this population about 80 per cent are of the farming class. Density of population, 52.4 per square mile. Of the entire population of the State, 20 per cent reside in the cities of 2,500 and upward. Of the total population 78.3 per cent are white and 21.7 per cent negroes. In the total population of the State there are 1,081,290 females and 1,103,491 males. The total voting population is 552,668, 78 per cent being white. The total number of children of school age (6 to 20 years) is 738,-478. The total number of illiterates in the State (over 10 years) is 221,071, representing 13.6 per cent of the total population, as compared to 20.7 per cent in 1900. The total number of dwellings in Tennessee is 444,814. Total number of families, 462,553. Average number per family, 4.7.

Immigration.— Immigrants to the State are heartily welcomed with that geniality and hospitality which the new South has inherited from the old. Tennessee is not dominated by the arrogance of wealth, neither is it overbalanced by its city population. Prejudice of the country against the town or of town against country is a thing of the past. The numerous commercial organizations offer inducements to capital with the assurance that though a stone wall might be built about the State, yet its resources are so great and diversified that even then 10 times its present population would have available every necessity, every comfort and every luxury. In conclusion, it may be said truly that Tennessee is large in area, in wealth, in industries and truly magnificent in its possibilities, and the day for indulging provincialism is forever gone.

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GEORGE C. PORTER.

TENNESSEE, a large river formed by the Holston from Virginia and the French Broad from North Carolina, which unite near Knoxville, in eastern Tennessee. It flows southwest, entering Alabama in the northeastern part of the State and continuing southwest to the centre of Marshall County, where it turns northwest and flows across the northern part of Alabama, re-entering Tennessee in Hardin County. From here the course of the river is nearly due north across the State of Tennessee and the western part of Kentucky, to the Ohio River, which it enters at Paducah, Ky. The length of the river is about 800 miles; from the source of the Holston to the mouth of the Tennessee is about 1,200 miles; the area drained is about 40,000 square miles. It is navigable, without artificial aid, to Florence, in Lauderdale County, Ala., a distance of 280 miles from Paducah. Just above Florence are the Muscle Shoals, about 20 miles long, which are navigable for about one month in the spring. A canal has been built to overcome this obstruction to navigation. Above the Shoals, the river is navigable for light-draft steamers nearly all the year. The navigable waters of the upper course of the river, together with the Holston, are about 930 miles. The principal tributaries are the Clinch, Duck, Elk, Hiawassee and Sequatchie rivers. The Tennessee is the largest tributary of the Ohio River, entering the Ohio 10 miles from the mouth of the Cumberland River. See BOUNDARIES OF THE UNITED STATES.

TENNESSEE, Army of the, one of the divisions of the Federal army in the Civil War. After the battle of Shiloh (q.v.) it was commanded by General Halleck and later by Grant, Sherman and others.

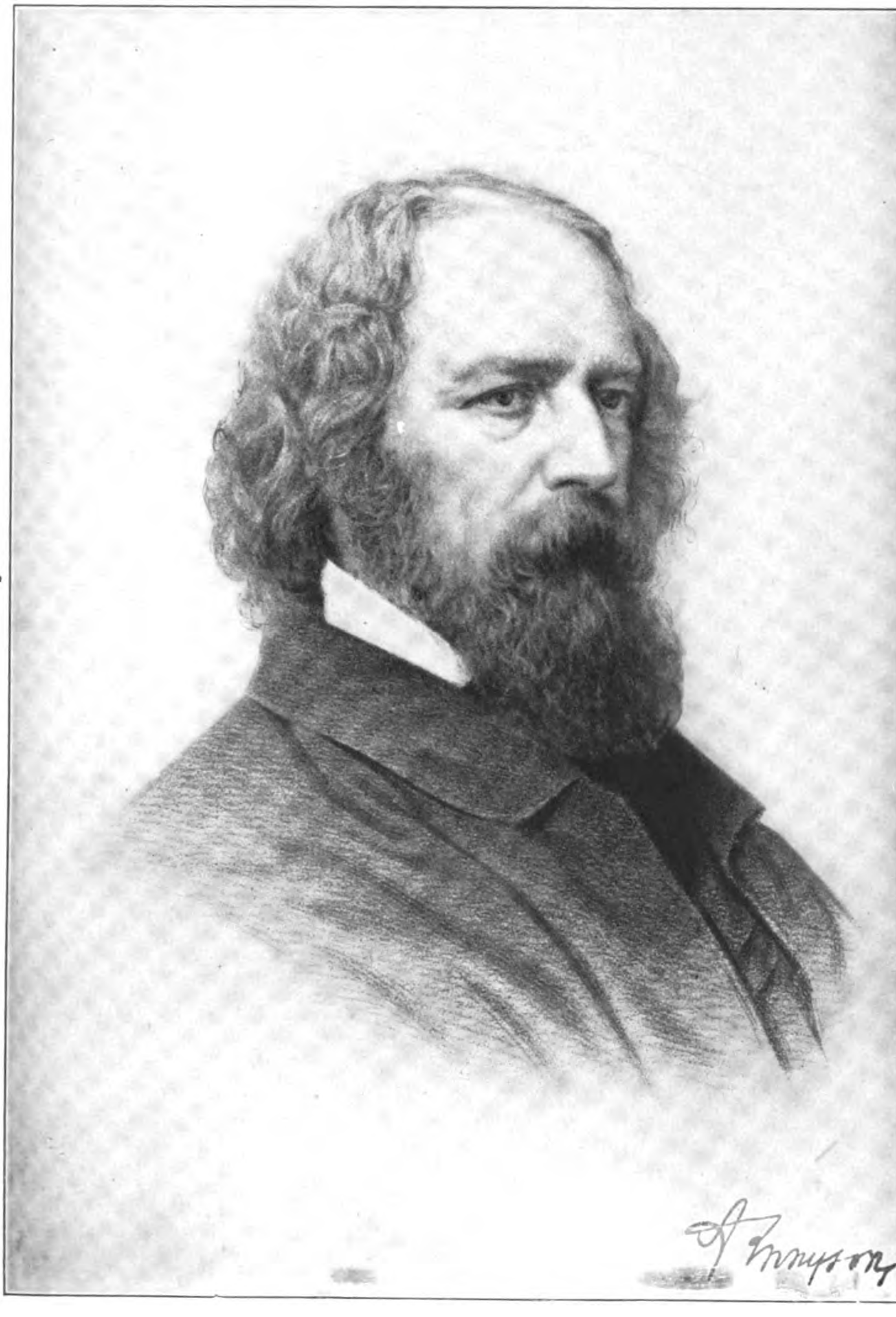
TENNESSEE, University of, the State university located at Knoxville, Tenn. It was established in 1794 as Blount College, a nonsectarian institution and was incorporated by the first general assembly of the Territory southwest of the Ohio; in 1807 the name was changed to East Tennessee College and in 1840 to East Tennessee University. In 1869 the State legislature gave to the university the control of the Congressional land grant of 1862; in 1879 it was further recognized as a State institution by an act connecting it with the public schools of the State, and in that year its name was changed to the University of Tennessee. The board of trustees consists of 14 members appointed by the governor and confirmed by the senate for a term of 12 years from each Congressional district and two each from Knoxville and Memphis; the governor, the commissioner of agriculture and superintendent of public instruction are additional members ex officio. The university is coeducational. It comprises colleges of liberal arts, agriculture, including experiment stations, engineering and law at Knoxville; colleges of medicine, of dentistry and school of pharmacy at Memphis. Military science and drill are a part of the curriculum and are required of the men students in the freshmen and sophomore classes. In 1902 a teachers' summer school was opened on the university grounds with the co-operation of the university authorities. (See SUMMER SCHOOL OF THE SOUTH). The university has a division of extension, including agriculture, home economics, public health, rural engineering and education. Short winter courses are given in the agricultural, home economics and engineering departments. The campus proper at Knoxville contains 39.9 acres, at Memphis 1.7 acres, and the university farms contain 1,634 acres; there are 18 buildings, including dormitories on the campus. The productive funds amount to $427,000; the annual income to approximately $500,000; the library contains 40,000 volumes. The students number 2,000 to 2,500 normally and the faculty over 200.

TENNESSEE CENTENNIAL EXPOSITION, held at Nashville, Tenn., in celebration of the State's 100th anniversary of its entrance into the Union. Its dominant purpose was to show the history and development of the State and to emphasize its resources. The site chosen was West Side Park, a former race-course, a tract of about 200 acres. More than 100 buildings were erected, and the departments included agriculture, art, commerce, customs, education and hygiene, government, history, machinery, minerals, forestry, transportation, women's work, etc. The president of the exposition was John W. Thomas. The total attendance was 1,786,714; the receipts were $1,101,285, exceeding by $39 the disbursements. Consult Justi, 'The Official History of the Tennessee Centennial Exposition' (1898).

TENNIEL, tĕn-nēl', SIR **John,** English cartoonist: b. London, 1820; d. 1914. He received no regular art training. In 1845 he was selected by open competition to paint a fresco in the Houses of Parliament at Westminster, but he is better known as a book-illustrator and a cartoonist in *Punch,* on whose staff he worked during the 50 years 1851–1901. He also illustrated a number of important books. He was knighted in 1893. His cartoons are unique as contributions to a comic paper, being of classic severity in line and expression and often tinged with a tragic seriousness of meaning which exhibits their author as not only a great caricaturist but also a great painter. Yet nothing can be more powerful than the political satire which characterizes the majority of them, a satire whose geniality neither deadens the life nor blunts the point of their irresistible humor.

TENNIS. See LAWN TENNIS; RACKETS.

TENNYSON, Alfred, LORD, English poet: b. Somersby, Lincolnshire, 6 Aug. 1809; d. Aldworth, near Haslemere, on the border of Sussex and Surrey, 6 Oct. 1892. His boyhood was passed at his father's country rectory, in an atmosphere that was full of poetry and music; and at a very early age he began to try his wings in verse. Some of his youthful efforts were published in partnership with his elder brother Charles, in 1827, in a volume entitled 'Poems by Two Brothers.' Two years later he entered Trinity College, Cambridge, and became a member of an intimate society called 'The Apostles,' which included some of the most brilliant young men in England. Among them was Arthur Henry Hallam, the closest friend of Tennyson. In 1829 he won the Chancellor's Medal with a poem in blank-verse called 'Timbuctoo'; and in the following year he published 'Poems, Chiefly Lyrical,' a slender volume of new and delicate melodies.



ALFRED TENNYSON

Soon after his father's death in 1831, he left college without taking his degree, and for 60 years that followed he gave himself to a poet's life with a clear resolution which never wavered.

His volume of poems published in 1832 marked a distinct growth in strength and skill. It was but a tiny book, but there was a quality in it which more than made good a lack of quantity. 'The Lady of Shalott,' 'Œnone,' 'The Lotos-Eaters,' 'The Palace of Art,' and 'A Dream of Fair Women,' revealed the presence of a true dreamer of dreams, gifted with the magic which translates visions into music. 'The Miller's Daughter,' 'The May Queen,' and 'New Year's Eve,' showed the touch of one who felt the charm of English rural scenery and common life with a sentiment, so fresh and pure and deep that he might soon be able to lay his hand upon the very heart of the people.

But before this highest potency of the poet's gift could come to Tennyson, there was need of a baptism of conflict and sorrow, to purify him from the mere love of art for art's sake, to save him from becoming an over-dainty weaver of exquisite verse, and to consecrate his genius to the severe and noble service of humanity and truth. This liberating and uplifting experience was enfolded in the profound grief which fell upon him in Arthur Hallam's sudden death at Vienna, in 1833. How deeply this irretrievable loss shook the poet's heart, how closely and how strenuously it forced him to face the mystery and the meaning of life in lonely spiritual wrestling, was fully disclosed, after 17 years, in the famous elegy, 'In Memoriam.' But the traces of the conflict and some of its fine results were seen even earlier, in the two volumes of 'Poems' which appeared in 1842, as the fruitage of a decade of silence. 'Ulysses,' 'Morte d'Arthur,' 'St. Simeon Stylites,' 'Dora,' 'Locksley Hall,' 'A Vision of Sin,' 'The Two Voices,' and that immortal lyric, 'Break, Break, Break,' were not the work of

"An idle singer of an empty day."

A new soul had entered into his poetry. His Muse had been born again, from above. He took his place with the master-minstrels who sing with a full voice out of a full heart, not for a coterie, but for the age and for the race.

It was the recognition that Tennyson really belonged to this higher class of poets — a recognition which at first was confined to a clear-sighted circle, but spread by degrees to the wider reading public — that prepared an expectant audience for his first long poem, 'The Princess,' which appeared in 1847. The subject was the eternal "woman question," treated in the form of an epic, half heroic and half humorous; the story of a king's daughter who sought to emancipate (and even to separate) her sex from man, by founding a wonderful woman's college, but was conquered at last (or at least modified), by the love of an amorous, chivalrous, dreamy prince, who wooed and married her. The story is unconvincing. The blank verse in which it is told has beauty, though it is often too ornate. The conclusion of the poem is a superb tribute to "the eternal womanly." But the little interludes of song which are scattered through the epic shine as the chief jewels in a setting which is not all of pure gold.

In 1850 the long-delayed and nobly-labored elegy on the death of Hallam was given to the world. It is hardly too much to say that 'In Memoriam' stands out, in present vision, as the most illustrious poem of the 19th century. Certainly it has been the most frequently translated, the most widely quoted, and the most deeply loved. It is far more than a splendid monument to the memory of a friend. It is an utterance of the imperishable hopes and aspirations of the human soul passing through the valley of the shadow of death. It is a unique group of lyrics, finished with an exquisite artist's care, which is only surpassed by the intense and steady passion which fuses them into a single poem. It is the English classic on the love of immortality and the immortality of love.

In the same year with the appearance of this poem happened the two most important events of Tennyson's career. He was married in June to Miss Emily Sellwood, a lady of rare and beautiful endowments, who proved herself through a long life of unselfish devotion the true partner of a poet's existence. And he was appointed in November to succeed Wordsworth as poet laureate.

His first official poem was the stately 'Ode on the Death of the Duke of Wellington,' in 1852. The majestic march of the verse, its freedom, its organ-toned music, its patriotic vigor, and the lofty solemnity with which it closes, give it a higher place than can be claimed for any other poetical production of an English laureate for a public occasion. 'The Charge of the Light Brigade,' written in 1854, was a trumpet-note that rang through England and echoed around the world.

'Maud' was published in 1855. It is a lyrical monodrama, in which the hero, a sensitive and morbid man, with hereditary tendency to madness, tells the story of his redemption from misanthropy and despair by the power of a pure love, unhappy but victorious. The variety of the metrical forms in this poem, the passionate tenderness of the love songs, the beautiful truth of the descriptive passages, and the intense personality of its spirit give it a singular charm, which is felt most deeply perhaps by those who are young and in love. Tennyson himself said "I think 'Maud' is one of my most original poems."

In 1859 began the publication of the epical sequence called the 'Idylls of the King'; the largest and in some respects the most important of the works of Tennyson. The first group contained 'Enid,' 'Vivien,' 'Elaine' and 'Guinevere.' The second group appeared in 1870, and consisted of 'The Coming of Arthur,' 'The Holy Grail,' 'Pelleas and Ettare' and 'The Passing of Arthur.' In 1872 'Gareth and Lynette' and 'The Last Tournament' were published; and in 1885 'Balin and Balan' was printed in the volume entitled 'Tiresias and Other Poems.' The division of 'Enid' into two parts — 'The Marriage of Geraint' and 'Geraint and Enid' — makes the epic, as it now stands, consist of 12 idylls. Each of these clothes an ancient legend from the Arthurian

Cycle in the richest and most harmonious of modern blank verse. The idylls are so far independent that any one of them might stand alone as a complete poem. But there is a connecting thread running through them all in the threefold love-story of Arthur, Guinevere and Lancelot, and in the history of the Round Table. The underlying motive of the whole series is to shadow forth the war of Sense against Soul. The idylls are to be interpreted, therefore, as movements in a symphony, the theme of which is the rightful royalty of man's spiritual nature, seeking to establish itself in a settled reign of law, and constantly opposed by the disorderly and disintegrating elements of humanity. In 'The Coming of Arthur' it is doubt that threatens the kingdom; in 'Gareth and Lynette' the conflict is with false ambition; in 'The Marriage of Geraint,' with pride; in 'Geraint and Enid,' with jealousy; in 'Balin and Balan,' with suspicion; in 'Merlin and Vivien,' with lust; in 'The Holy Grail,' with superstition; until at last the poison of unlawful love has crept through all the court, and Arthur's Round Table is dissolved in ruin — but not without a vision of peace for the king who has kept his soul unstained, and a dim promise of new hope for some future age, when he shall return to bloodless victory.

Tennyson has not allowed the ethical purpose of these poems to confuse their interest or bedim their beauty. They are not in any sense an allegory. The tales of love and knight-errantry, of tournament and battle and quest, are vividly told in the true romantic spirit, lighting up the olden story with the thoughts and feelings of to-day. There is perhaps a touch of over-elaborateness in the style; but after all the figures stand out as distinctly as they ought to do in such a large tapestry. In the finer idylls, like 'Guinevere' and 'The Passing of Arthur,' the blank verse moves with a grandeur and dignity, a broad, measured, fluent harmony, unrivaled in England since Milton's organ voice was stilled.

The rest of Tennyson's poetical work includes his dramas — 'Queen Mary,' 'Harold,' 'Becket,' 'The Cup and the Falcon,' and a few others — and several volumes of miscellaneous poems: 'Enoch Arden' (1864); 'The Lover's Tale' (1879); 'Ballads' (1880); 'Tiresias' (1885); 'Locksley Hall Sixty Years After' (1886); 'Demeter' (1889) and 'The Death of Œnone,' published posthumously in 1892. The great age to which his life was prolonged, the unswerving fidelity with which he devoted himself to the sole pursuit of his chosen art, the freshness of spirit which made him delight in labor to the very last, and the fine versatility of mind with which he turned from one field of production to another — brought it to pass that both in amount and in variety of works Tennyson stands in the front rank of English poets; but two can be thought of — Shakespeare and Robert Browning — who produced more.

In 1883 a title of nobility was offered to Tennyson through Mr. Gladstone. This honor, which he had declined at least once before, he now accepted; and in January 1884 he was admitted (we can hardly say elevated) to the peerage — taking his title, Baron of Aldworth and Farringford, from his two country houses, in Sussex and in the Isle of Wight.

It would be difficult, of course, to characterize the style and estimate the value of such a varied and fertile poet in a brief essay. But there are certain qualities in the poetry of Tennyson which are unmistakable and vital.

1. His diction is singularly lucid, smooth and melodious. He avoids sharp and strident effects. Not only in his choice of metres, but also in his choice of words and cadences, we feel a musical influence controlling his verse. Sometimes this results in a loss of force or definiteness. But it makes his poetry, whether in the long swinging lines of 'Locksley Hall,' or in the brief simple measures of the shorter songs, eminently readable. Any one who recites it aloud will find how natural it is to fall, as Tennyson always did, into a rhythmical tone, almost like chanting. This close relation of his poetry to music may be felt also in the quality of subtle suggestiveness, of intimate and indefinable charm, which makes his brief lyrics as perfect as anything of their kind in the world's literature. He has the power of expressing the vague, delicate, yet potent emotions, the feelings that belong to the twilight of the heart, where the glow of love and the shadow of regret are mingled, in verbal melodies as simple and as magical as the chime of far-off bells, or the echoes of a bugle-call dying among the hills.

2. He has an extraordinary truthfulness and delicacy of touch in natural description. This appears equally in minute, pre-Raphaelite work, where he speaks of the color of the buds on different trees in early spring, or in the way in which a wave-crest is reflected in the smooth hollow before it breaks; and in wide, vague landscapes, where he renders the turbulence of the coming storm, or the still glory of an autumnal morning, in a few broad lines. Add to this the quality of blending and interfusing all his epithets and descriptions with the sentiment of the poem, so that they do not distract the feeling but enhance and deepen it, and you have one of the traits by which the poetry of Tennyson is most eagerly distinguished.

3. His range of imaginative sympathy, as shown in his ballads and character pieces, is very wide; but it moves for the most part along natural and normal rather than strange and eccentric lines. His dramatic lyrics differ in this respect from those of Browning. Tennyson expresses the feeling of the philosopher in 'Lucretius,' of the peasant in 'Rizpah,' of the child in 'The Children's Hospital,' of the old sea-fighter in 'The Revenge,' of the intellectual adventurer in 'Ulysses,' in order to bring out in each, not that which is exceptional and rare, but that which is most deeply human and typical.

4. His work reflects with singular fidelity the scientific and social movements of the age. The discoveries and inventions of modern times are translated into poetic language and turned to poetic use. In his verse the earth moves, the planets are molded of star-dust and the mystery of an unfinished creation is still in evolution. It is possible, often, to assign dates to his poems by an allusion to some newly-seen moon or comet, or some critical event in the social history of mankind. It is true that he mistrusts many of the new devices to bring in the millennium. He takes a dark view of some of the elements of 19th century civilization. But still he feels the forward movement of the world;

and his poetry mirrors truly the spirit of modern optimism — with shadows.

5. As in its form, so in its spirit, the verse of Tennyson expresses a constant and controlling sense of law and order. He is in the opposite camp from the poets of revolt. Harmony is essential to his conception of beauty. His patriotism is sober, steadfast, thoughtful, law-abiding. His love moves within the bounds of order, purity and reverence. His conception of power is never akin to blind force, but carries within itself the higher elements of intelligence and voluntary restraint.

> Self-reverence, self-knowledge, self-control, —
> These three alone lead life to sovereign power.

6. The poetry of Tennyson is pervaded by a profound religious spirit. His view of the world — his view even of the smallest flower that blossoms in the world — is illuminated through and through by his faith in the Divine presence and goodness and beauty. He cannot conceive of a purely physical universe. Nothing that he has written could have been written as it is, if he had been an atheist or an agnostic. Even his poems of doubt and conflict are the resurgent protests of the heart against the cold negations which destroy personal trust in the unseen God, in whom we live and move and have our being. His method of dealing with religious subjects is not theological, like that of Milton or Wordsworth; nor philosophical, like that of Browning or Arnold or Clough. Tennyson speaks more from the side of the feelings, the ultimate spiritual instincts and cravings of humanity. The strongest of these is the desire and hope of a life beyond the grave. To this passion for immortality he gives full play, and it evokes some of the strongest and sweetest tones of his music. From 'The Deserted House' to 'Crossing the Bar,' his poetry is an evidence of his conviction that death cannot end all. This faith in the life that is to come elevates and purifies his conception of the life that now is. It gives a new meaning to duty and to love. And when we think of the many noble poems in which it has found expression,—'The Two Voices,' 'The May Queen,' 'Locksley Hall,' 'Enoch Arden,' 'The Leper's Bride,' 'Guinevere,' 'In Memoriam,' 'Vastness,' 'Wages,' — we may well call Tennyson the poet of the endless life.

His influence upon the thought and feeling of the age has been far-reaching and potent. He has stood among the doubts and confusions of these latter days as a witness for the things that are invisible and eternal,— the things that men may forget if they will, but if they forget them, their hearts wither and the springs of poesy run dry. His verse has brought new cheer and courage to the youth of to-day who would fain defend their spiritual heritage against the invasions of materialism. In the vital conflict for the enlargement of faith to embrace the real results of science, he stood forth as a leader. In the great silent reaction of our age from the desperate solitude of a consistent skepticism, his voice was a clear-toned bell, calling the unwilling exiles of belief to turn again. And when he passed away from his quiet home at Aldworth, with the moonlight falling on closed eyes and voiceless lips, the world mourned for him as for a mighty prophet, and rejoiced for him as a poet who had finished his course and kept the faith. See ENOCH ARDEN; IDYLLS OF THE KING; IN MEMORIAM; LOCKSLEY HALL; MAUD; PRINCESS, THE.

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HENRY VAN DYKE,
Professor of English Literature, Princeton University, and former United States Minister to the Netherlands and Luxembourg.

TENNYSON, Frederick, English poet: b. Louth, 5 June 1807; d. Kensington, 26 Feb. 1898. He was elder brother of Alfred Tennyson (q.v.). He published several volumes of poems of considerable merit, namely: 'Days and Hours' (1854); 'The Isles of Greece' (1890); 'Daphne and Other Poems' (1891); and 'Poems of the Day and Year' (1895).

TENNYSON-TURNER, Charles, English poet: b. Somersby, Lincolnshire, 4 July 1808; d. Cheltenham, 25 April 1879. He was an elder brother of Alfred Tennyson (q.v.), with whom he collaborated in the 'Poems' of 1827. He took the additional name of Turner by royal license on succeeding to property at the death of a great-uncle. He became vicar of Grasby, Lincolnshire, in 1837, and published 'Sonnets' (1864); 'Small Tableaux' (1868), and 'Sonnets, Lyrics and Translations' (1873). In 1880 these were republished with additions, under the title 'Collected Sonnets, Old and New.' These writings manifest that he possessed much poetic genius. His greater brother regarded some of his sonnets as among the finest in the language, among them being 'The Rookery'; 'Letty's Globe'; 'Orion'; and 'The Lion's Skeleton.'

TENOCHTITLAN, tĕn-ŏch-tĕt-län', the ancient name of the City of Mexico. See MEXICO.

TENOR, the highest natural adult male voice. Its compass generally extends from C in the bass to G or A in the treble. Professional singers may take from C to C. The qualities of the tenor render it suitable to the expression of tender and delicate sentiments. In a vocal composition of four parts the tenor forms the second middle part, deeper than the alto, but higher than the bass; but in the song of four male voices the tenor, as the first voice, leads the chief melody, and as the second is the higher middle voice. The clef of this voice is the C clef on the fourth line of the stave, but the treble or G clef is commonly used, though an octave too high. A singer having a high-pitched voice, or a musical part for such a voice, is also termed tenor, and sometimes a viola tuned between the bass and the alto is so named. See VOICE AND VOICE CULTURE.

TENORITE, the native black oxide of copper, CuO. It occurs on the lavas of Vesuvius in small black scales of brilliant metallic lustre. Melaconite is an earthy, massive variety, resembling wad, formed by the decomposition of chalcopyrite and other copper ores. It occurs in Ducktown, Tenn.; Morenci, Ariz., and elsewhere.

TENOS, tē'nŏs, Greece. See TINOS.

TENSAS, a river in the southwestern part of Alabama, the eastern channel through which the united waters of the Tombigbee and the Alabama rivers pass to Mobile Bay. The western channel is called Mobile River (q.v.). At the mouth of the Tensas is Fort Blakely where took place an engagement between the Union forces and the Confederates, 25 March 1865. See FORT BLAKELY, SIEGE AND CAPTURE OF.

TENSKWATAWA. See TECUMSEH.

TENT, a portable dwelling-place formed of flexible material, as blankets, hides or more commonly canvas, stretched with cords on poles. Tents are chiefly used in Europe and the United States as shelters for soldiers, although the first hunters in this country, following the Indians, made partial use of them. The most common form of tent is the A tent, having a ridge-pole, across which a canvas is slung and sloped to form the main roof, the sides being fastened by cords to stakes in the ground, and flies or wings being hung for sides. When a hoop is used instead of a ridge-pole as the main support it is a bell-tent. The circus tent usually has two, three or more main masts, with ridge-poles or ropes between them, and a vast spread of canvas reaching to the ground.

TENT-CATERPILLARS, caterpillars of some moth of the genus *Clisiocampa,* specifically the apple-tree or spring species (*C. americana*) of the northeastern States. The moth is of medium size and plain colors. Its eggs are laid in autumn in the form of bands of 300 to 400 glued about the twigs of fruit-trees. They hatch early in spring, and the caterpillars begin to spin across nearby forking twigs a triangular silken web or tent, in which they take shelter and grow; many other trees as well as those of the orchard are affected. They go out in the daytime to feed on foliage and at night gather inside the web, which should be burned at night when it is populous, or destroyed by a spray of kerosene. The caterpillars become full grown in June, and then are about two inches long, hairy, with a white dorsal stripe and with numerous fine crinkled black lines on a yellow ground, united below into a common black band, with a blue spot on the side of each ring. Then the caterpillars spin their dense white fuzzy cocoons behind the loose bark, or boards, and the moths appear about July 1. Another species, often very destructive to the foliage of shade-trees, is the forest tent-caterpillar moth (*C. disstria*), whose caterpillars are to be distinguished by a row of spots instead of a line along the back. The more common tent-caterpillars of the Pacific Coast are the larvæ of the early *C. californica* and of the later *C. constricta,* both orchard-pests. The last-named live in colonies but do not make tents.

TENTACULIFERA, a sub-class of the *Infusoria* having no cilia in the adult condition but provided with them during the embryonic period. The distinguishing feature of the group is found in the so-called tentacles which are very highly differentiated organs, some adapted for sucking and some for piercing, while some again are adhesive. They are emitted from the entire surface of the body or occur in groups at the angles. Such tentacles are elongate, capable of protrusion and retraction, and usually have the distal end expanded into a sucker. In structure a tentacle is tubular with a semi-fluid plasm in the axis and a firm outer portion. When partly retracted a band of contractile protoplasm appears as a spiral ridge around the outside. There are several branching forms such as *Dendrocometes*, sessile on the gill plates of small fresh-water crustacea, and *Dendrosoma*, a larger colony, attaining sometimes a length of two millimeters and presenting superficially an extraordinary resemblance to a zoophyte. In the latter the nucleus extends as an axial structure branching throughout the entire colony. Young forms are produced by division or gemmation, and are free-swimming by virtue of a ciliary covering which is replaced by the tentacles when the organism settles down in a permanent environment.

TENTH CENTURY. The tenth is commonly rated in history as one of the lowest of centuries in achievement. Undoubtedly fewer monuments and documents representing physical or intellectual accomplishment have come down to us from it than from corresponding periods. The principal reason for this is to be found in the almost continuous invasions of the Northmen who at this time disturbed most of the western European countries. They established themselves in France under Rollo in the early part of the century. They landed on the English coast in larger numbers than ever, they invaded Ireland and destroyed particularly the monasteries and schools. They sailed around into the Mediterranean and made incursions on the cities and established themselves in Sicily and southern Italy. No wonder that the monastic chroniclers were not active and that men were discouraged over making attempts at progress. While these sea robbers came from the North the Saracens from Arabia were making similar incursions in the East and the eastern portion of the Mediterranean. It was the state of unsettledness of mind induced by the attacks of these two sets of invaders and the inhibitions set up by their savage cruelties and not, as is sometimes said, the persuasion that the world was to come to an end in the year 1000 which dulled the efforts of the generations of the time.

The 10th century was, notwithstanding, a significant transition period in which occurred many events that were to be fundamentally constructive for modern history. The Northmen consolidated their power in Russia and are usually said to have given a name and a certain stability to the government of the country at this time. They explored Greenland and probably landed on the American continent in the region known as Vineland, somewhere south of Labrador, before the year 1000. Their invasion of England was to lead to the establishment of Canute's empire in the next century and their presence brought about a consolidation of some of the warring peoples of Europe and an improvement in political conditions. They introduced a new racial element into the life of what we know as France and the Normans, as they were called, became an extremely important factor in the subsequent history of Europe. At the same time the Arabs in Spain became leaders in the intellectual life of Europe and their schools in Cordova of geometry, chemistry, astronomy and medicine made that city a centre of learning famous throughout the world. Cordova laid the foundation of that profound Arabic interest in science and medicine which in the following two centuries gave us Abulcasis, Avenzoar, Averroes and Avicenne and was to mean so much for the stimulation of the scientific spirit of Europe. There was a great Arabian physician in the East too, Rhazes, the first to describe smallpox, whose books are still famous in the history of medicine.

In spite of the ever recurring incursions of the Northmen the political development of Europe at this time is of special interest to modern history. The 9th century saw the breaking up of Charlemagne's Empire by divisions among his sons as well as among the sons of succeeding rulers to whom unfortunately the government by the Frankish custom was parceled out. The result was that France without a firm central authority was in a highly disturbed state all during the 10th century. The feature of European history most interesting for our time is the bitter rivalry between the Germans and the French over the possession of Lorraine which culminated nearly a thousand years ago. The German emperor of that time, Otto, invaded and devastated all the country of the Franks almost to Paris, then was forced to make a disastrous retreat and the greater part of his army perished in a battle on the Aisne.

England after the magnificent reign of Alfred continued for some time to grow in peace and prosperity. Alfred's son Edward (reigned 901–25) conquered Mercia and East Anglia, strengthened the government and protected his people against invasion by the building of many strongholds. He encouraged town development and patronized learning, founding schools, though the tradition of any connection between the Saxon schools of this time and Oxford or Cambridge is mythical.

Æthelstan (925–40) further extended the Saxon rule so that all of the old Saxon Heptarchy (seven kingdoms) came under his dominion. He commanded in the "great battle" famous in subsequent history against an allied army of Danes, Scots, Gaels and warriors from the Orkney Islands. These Northern peoples with their great claymores always struck terror into their enemies before this but Saxon troops proved capable of withstanding their charge. Æthelstan came to be looked upon as one of the most important kings of Europe and royal alliances with his family were eagerly sought, his sisters Edwina and Editha marrying the kings of France and Germany. He may be called the first king of all England. In the second half of the century, however, the Northmen landed in England in large numbers and gradually secured a firm foothold. The Danes under their king, Sweyn, threatened to overrun the country and their withdrawal was obtained only by paying a ransom. Needless to say this only proved to be a bait for more invaders from the Northern countries.

A more hopeful development came at the end of the century with the introduction of Hungary into European history. Stephen, one of the chiefs of the Hungarians, was with his father received into the Church and proceeded to make his people Christian. He was crowned as king (997) and his reign is mainly in the next century, but the spirit which led him to correspond with Bruno of Querfort and Odilo of Cluny and to found a series of hospices for pilgrims in Jerusalem, Rome, Ravenna and Constantinople so that travelers from his country might have a refuge when they visited these cities, was a product of the 10th century. He encouraged learning and did much to break the savage spirit of his people. His court became a refuge for the English royal family when Canute conquered the English and he deeply influenced Saint Margaret of Scotland. The tradition of social helpfulness established by him culminated in Saint Elizabeth of Hungary in the next century.

The one country in western Europe in which the Northmen were unable to gain foothold was Spain. When the Northmen landed at Galicia they devastated the country for a while, but were defeated and almost exterminated learning a lesson that kept Spain from being seriously disturbed by the Scandinavians after this. This century witnessed also the beginning of the expulsion of the Moors. The foundation of the little Christian kingdom of Leon was the initial step in this and the prelude to the heroic age celebrated in the Spanish chronicles and ballads. Abderrahman III (891–961) under whom as caliph of Cordova, Mohammedan power in Spain rose to its greatest height, was defeated in 940 by Ramiar II, king of Leon and Asturias (died 950), in the great battle on the plain of Simancas (31 July 939). After this the Christians continued to advance in power and the Arabs to recede.

The most interesting character of the period is Dunstan, archbishop of Canterbury, proclaimed saint by popular estimation of the good work he did for his people. He was probably born early in the century of a well-to-do family. In his youth he was a favorite at court until jealousy led to his banishment. Disillusioned with worldly success he became a hermit at Glastonbury but after a time the fame of his life as a solitary led the king to recall him as an adviser. Dunstan took advantage of his place at court to encourage learning and patronize art. He himself was deeply interested in the arts and crafts and the making of beautiful things and after his death he became the patron saint of the goldsmiths' guild. He is said to have taken part in the making of bells and organs as well as the altar vessels. Nothing delighted him more than the teaching of boys in the cathedral school and he encouraged manual training as well as intellectual development. The rich who saw his good work provided him with funds in abundance and he used them for the building and restoring of churches and the establishment of schools. He reformed monastic life which had suffered severely during the disturbed period while the Northmen were landing in England. Dunstan was most famous, however, for his care of the poor and the needy. He was often called upon to act as judge in law suits and his maintenance of the rights of widows and orphans made him popular. He died in 988 and until the martyrdom of Saint Thomas of Canterbury was the favorite saint of the English people.

The most significant intellectual event of the century was the writing of a series of plays by Hroswitha, a Benedictine nun of Gandersheim, South Germany. Her reasons for writing them, as given in the preface, makes it very clear that there must have been much more of interest in literature, classic and recent, at this time than is usually thought. Hroswitha declared: "There are many Christians (and we cannot relieve ourselves entirely of this reproach) who charmed by the choice eloquence of the language, prefer the vanity of secular books to the wisdom of the Holy Scripture. There are others who though attached to the sacred writings and full of contempt for other pagan productions, yet cannot keep from reading time and again the fictions of Terence and won by his charm of diction stain their souls by the knowledge of criminal actions. It is for this that I, 'the strong voice of Gandersheim,' do not hesitate to imitate in my writings a man whom so many permit themselves to read in order to celebrate in the measure of my feeble intellect the virtues of Christian women while employing the same form of composition which served the ancients to describe shameful conduct."

The ideas thus expressed are so modern that it is surprising to find them thus simply set forth in the 10th century. Hroswitha called her plays comedies because they end happily, though the happiness comes in heaven through martyrdom. They were probably meant, as the preface would seem to indicate, more for reading than presentation, though they are some comic scenes that would tempt the employment of the actors' art. One of Hroswitha's comedies anticipates the morality plays of subsequent centuries in their introduction of abstract characters personified. Wisdom, the mother, and her three daughters, Faith, Hope and Charity, came to Rome to influence the citizens for good and are put to death by the Emperor Adrian. Besides the dramas Hroswitha wrote a series of poems in Latin verse, one of which is the story of Theophilus who sold his soul to the devil and is one of the early forms of the Faust legend. She also wrote a chronicle and seems to have been in high favor at court. The *editio princeps* of Hroswitha is by Celtes (1501). At first he was suspected of having written most of the plays, but there is no doubt now of their antiquity. The work throws light on the feminine education of the time. Manifestly the convents, of which there were many in the Rhineland, contained a number of religious women deeply interested in the intellectual as well as the spiritual life.

The beginnings of some of the important developments in commerce date from this century. Merchants were honored by Æthelstan who conferred the rank of Thane on anyone who had made three voyages over the sea with a ship and cargo of his own. The British fleet organized by Alfred at the end of the 9th century developed and in King Edgar's time (959–75) some 360 sail in three squadrons made a circuit of the island. Even this sea power was not able to protect England from invasion by the Danes, however, who under Sweyn gained a foothold (circa 985) and in the next century England was ruled by Canute. Flanders became the seat of manufactures of linens and woolens for Europe and the republics of Venice and Genoa began their great commercial careers in connection with the trade from the East. The Moors in Spain under Abderrahman III built some beautiful buildings and adorned their cities and set an example which was to prove an inspiration for the many students who came down to the Spanish Peninsula to make their studies at famous Moorish schools.

PRINCIPAL EVENTS OF THE TENTH CENTURY.

905. Edward the Elder, King of the Angles and Saxons, second son of Alfred the Great, makes peace with the Danes settled in East Anglia and Northumbria, and establishes the "Laws of Edward and Guthrum."
909. Northmen from Norway and Denmark, from this year on, through the century, continue to ravage the Russian, German, British, Irish and French coasts, and although disastrously repulsed from Spain, extend their depredations to Italy. They establish colonies in Normandy, France, under Rollo, in England and in the northern Scottish islands.
911. Conrad, duke of Franconia is elected emperor of the Franks.
918. Henry the Fowler becomes Henry I., King of Germany.
919. Germany and north Italy are divided into dukedoms and principalities. The third or Saxon dynasty commences. Henry I extends his territory; increases civic rights; creates several margravates. The silver mines of Hertsburg are discovered. Industry and wealth increase. Edward the Elder, King of the Angles and Saxons, is "chosen as father and lord" by Scots, Northumbrians, Danes, Norwegians and Welsh after victorous campaigns.
924. Edward the Elder dies and is succeeded by Æthelstan who consolidates the Saxon Heptarchy.
929. Otto of Germany, eldest son of Henry I, marries Edith, daughter of Edward the Elder, and sister of Æthelstan, King of England.
934. Henry I of Germany stems the Hungarian invasion.
936. Otto I, the Great succeeds his father Henry I as King of Germany.
942. Otto concludes peace with Louis IV of France after war over Lorraine.
953. War again breaks out over Lorraine and is ended by Otto's brother Bruno, Archbishop of Cologne.
955. The Hungarians are finally driven out of Germany, Otto defeating them in a brilliant victory at Lechfeld. Otto also defeats the Slavs who had ravaged Saxony.
959. Hugh Capet is made Duke of France.
968. Hroswitha, dramatist, Benedictine religious, and "the strong voice of Gandersheim," presents her 'Carmen de gestis Oddonis' to the emperors Otto I and Otto II.
971 Edward the Martyr becomes King of England.
978. Edward is assassinated at the instigation of his stepmother.
983. Greenland is colonized from Iceland by Northmen who send Christian missionaries there. They also reach Vineland on the North American continent.
987. On the dissolution of the Franconian Empire and the termination of the second dynasty, Hugh Capet the founder of the third dynasty is elected King of France.
988. Saint Dunstan, archbishop of Canterbury, dies.
997. Stephen I is crowned King of Hungary and enters into friendly relations with Christian leaders of Western Europe.
999. Austria becomes a Margravate. The Grecian Empire loses territory to the Bulgarians on Mount Hæmus and resists Russian invasion. The Turks in possession of Egypt and Syria extend their empire and give the title of Sultan to their rulers.
1000. Civilization advances. Villainage or serfdom is abolished in Western Europe. The principal towns become republics. Hereditary estates on a military basis are established. The dukes and counts become kings. Arabic learning attains a high standard. The Institutions for education founded by Charlemange are almost obliterated in the upheavals of the Franconian Empire, but faith and learning are safeguarded by the Church, for the intellectual advance and uplift of humanity.

JAMES J. WALSH,
Author of 'The Thirteenth Greatest of Centuries.'

TENURE is a legal term denoting the manner in which the title to real estate is held. It originated during the feudal system of England and defined the relation which existed between the lord of the manor and the tenant. The term tenure in its modern signification is extensive and may import mere possession of real property, or the particular manner by which same may be held. A tenure paid for in services was formerly known as socage. See also FEUDAL SYSTEM.

TENURE OF OFFICE, the manner by which an office is held, as well as the duration of its term.

TENURE OF OFFICE ACTS. (1) An act of 15 May 1820 which provided a four-year term for certain officers, such as collectors of customs, etc. (2) An act of Congress passed in 1867, vetoed by President Andrew Jackson and passed over his veto on 2 March. The chief provision of the act was that requiring the consent of the Senate to the removal of any officer appointed with its advice and consent. In case of the misconduct of officers thus appointed, except judges, when the Senate was not in session, the President might suspend such officer and designate another to perform his duties until the Senate should act in the case. Many other objectionable provisions were included in the bill, which was aimed at limiting the power of President Johnson. The latter's disregard of the act in removing E. M. Stanton from the Secretaryship of State was one of the main grounds of his impeachment. Under Grant's administration in 1869 many sections of the act were stricken out, and in 1887 it was practically repealed altogether. (See JOHNSON, ANDREW). Consult McLaughlin and Hart, 'Cyclopedia of American Government' (New York 1914), and 'Statutes at Large' (III, 582; XIV, 430; XVI, 6; XXIV, 500).

TEOCALLIS, tē-ō-kăl'ĭs, the ancient temples of Mexico, of which there are extensive remains. They are distinguished by a pyramidal base, square in plan, and rising in stories or terraces, or in an incline of 45 degrees, to an upper platform, on which the temple stands. The most extensive is the pyramid of Cholula, near Mexico, said to have been built before the arrival of the Aztecs. In plan it measures 1,440 feet each way, and has four terraces, reaching a height of 177 feet. Its area is nearly four times that of the great Egyptian pyramid, but in strength of material and skill of workmanship it is vastly inferior, and is now merely a mass of ruins. At Palenque, in Yucatan, is a better-preserved temple. The pyramid rises in an incline, consisting of an unbroken flight of steps, 280 feet square and 60 feet high. The temple is 76 feet wide in front and 26 feet deep and is ornamented with bas-reliefs in stucco and hieroglyphic tablets.

TEOSINTE, a fodder-plant. See GRASSES OF THE UNITED STATES.

TEPHROITE. A mineral consisting of manganese ortho-silicate $2MnO.SiO_2$, contains 70 per cent MnO.; abundant at Franklin Furnace and Sterling Hill, N. J.

TEPIC, tä-pēk', Mexico, (1) A territory on the Pacific Coast between the states of Jalisco and Sinaloa, organized under Mexican government in 1889; area, 11,275 square miles. It is a mountainous country inhabited by tribes of semi-independent Indians. It includes the volcano of Ceboruco, still active. The Santiago and Mezquital rivers flow through it. There are rich mineral deposits, little operated. Pop. about 175,000. (2) The capital, Tepic, lies about 25 miles inland from the port of San Blas, with which it is connected by a railroad. It stands on a commanding plateau, and manufactures cotton-cloth and tobacco, and has a population of about 17,000.

TEPLITZ, tĕp'lĭts, or **TÖPLITZ**, tėp'lĭts, Bohemia, a watering place in a mountain valley, 30 miles southeast of Dresden. Its interesting features are the castle with its beautiful grounds, the town church, bathing establishment, Rathhaus, etc. Its mineral baths are the most celebrated of the country. They consist of 12 hot springs, alkalo-saline, and are of great efficacy in rheumatic affections. The Triple Alliance between Austria, Russia and Prussia against France was signed here in 1813. Pop. 27,000.

TERAMO, tā'rä-mō, Italy. (1) Capital of the province of its own name, at the confluence of the Tordino and Vezzola, 40 miles northwest of Chieti. It is a bishop's see, and the cathedral dates from the 14th century. Municipal offices and the exchange are the principal buildings. The remnants of Roman baths, theatre, temples and aqueducts indicate the site of the ancient Interamna. The manufactures include wax, pottery, leather, straw hats, ornamental furniture and cream-of-tartar. The ascent of the Gran Sasso is made from this point. In 1460 a fierce battle was fought here between the Milanese allies of the king of Spain and the forces of the Duke of Anjou of France. The ruins of the castle of San Flaviano, in the plains nearby, mark the site of this conflict. Pop. of the commune about 25,070. (2) The province lies in southern Italy, and is traversed on the west by the Abruzzi Mountains. Several streams flow through the province to the Adriatic. Wine, grain, oil and silk are the chief products, and the fisheries are important. The Ancona-Brindisi Railway follows the coast, with a branch to Teramo, the capital. Pop. 320,000.

TERAPHIM, small images or objects similar to the household gods of the Romans, and which are mentioned in several places in the Bible. The reverence paid to them appears to have been very ancient. They were human in form, and from being merely venerated, or used as aids to devotion, might easily become objects of idolatry. The earliest mention of teraphim is in Genesis (ch. xxxi, 19), where Rachel is said to have stolen her father's teraphim, which Laban (ver. 30) calls his gods. In the story of Micah (Judge xv, 5) the word occurs in our Authorized Version. It was a teraph that Michal, David's wife, put into the bed (1 Sam. xix, 33) to deceive the messengers of Saul. Josiah is represented (2 Ki. xxiii, 24) as putting away the teraphim. In Ezek. xxi, 21 they are represented as used by the king of Babylon for purposes of divination. Consult Benziger, I., 'Hebraische Archaologie' (Tübingen 1907).

TERATOLOGY, that branch of biological and anatomical science which treats of abnormalities or monstrous growths in the structure of plants and animals. While ancient writers dealt with such deviations from normal types of structure, malformations appealed to their imagination as portentous objects of satanic origin, rather than to their deficient scientific sense as subjects of investigation. Early in the 18th century superstition began to give way to physical observation, and the study of character and causation in monstrosities became an important branch of natural history. Defect in the germ is regarded by many embryologists as the original cause of some human anomalies, hereditary persistence of certain deformities in numerous cases resulting. Other malformations are believed to be due to diseased organs, as the brain or the uterus, and to various fœtal disorders. Consult Moquin Tandon, 'Eléments de teratologie végétale' (1841); Fisher, 'Diploteratology,' in 'Transactions' of the Medical Society of the State of New York, 1865–66–67–68; Masters, 'Vegetable Teratology' (1869); Penzig, 'Pflanzenteratologie' (1890–94).

TERBIUM, one of the "rare earth" elements found chiefly in the minerals samarskite and gadolinite. It belongs to the yttrium group and has an atomic weight of 158.8. Its symbol is Tb.

TERBORCH, tĕr'boorH, **Gérard**. See TERBURG, GÉRARD.

TERBURG, tĕr'boorg, **Gérard**, Dutch painter: b. Zwoll, near Overyssel, 1608; d. Deventer, 1681. His father, a historical painter, who had resided some time at Rome, gave him his first lessons in painting. He continued the study of his art at Haarlem, and afterward visited Germany, Italy, Spain, England and France, leaving everywhere proofs of his talents as a painter of portraits and of interiors. On the meeting of the European Peace Congress at Münster he painted in 1648 'The Plenipotentiaries Discussing the Treaty' which contains 69 portraits; it is now in the English National Gallery. The Spanish Ambassador at the congress took him to Madrid, where he painted the king and many of the nobles. From Spain he went to London, and afterward to Paris. He then returned to Overyssel, married one of his nieces and became burgomaster of Deventer. His portraits are remarkable for elegance. He excelled in painting textile fabric, particularly satin and velvet. His interiors are mostly of the houses of the rich. Few of his pictures are to be found and they are exceedingly costly, his 'Glass of Lemonade,' a small canvas, 25¾ by 20¾, fetching in 1878 the price of $9,720.

TERCEIRA, tĕr'sā'rä, the third in size of the Azores Islands, situated 84 miles northwest of Saint Michaels; area 225 square miles. It is volcanic and mountainous, with steep cliffs along the shores, the highest point being about 3,500 feet. The soil is fertile, producing wheat, corn and grapes. The capital is Angra, with a pop. of 11,000. Pop. of the island about 50,000.

TERCENTENNIAL EXPOSITION AT JAMESTOWN. See JAMESTOWN TERCENTENNIAL EXPOSITION.

TEREBRATULA, a genus of brachiopods (q.v.). The shell exhibits a punctated structure, due to the presence of numerous minute canals in the shell-structure itself. The ventral valve has a prominent "beak," which is perforated for the stalk. Some species still exist in our seas, although the genus dates back to the Devonian age.

TEREDO, or **SHIP-WORM**, a small marine bivalve boring mollusk (*Teredo navalis*), which excavates burrows in wood under (salt) water, attacking the timbers of piers and vessels in immense numbers, and riddling them to such an extent that they are rendered utterly useless, in a surprisingly short time, if left unprotected. It abounds destructively throughout the Mediterranean and Baltic seas, and on both shores of the Atlantic. Its steady burrowings once almost caused the inundation of a large part of Holland. Along the sea-front had been built a system of dikes, made principally of timber. In three years breaks were being patched up; in five, whole sections gave way. Only the heroic efforts of the whole seaside population saved the Dutch from one of the worst catastrophes in their history. The timbers were completely honeycombed, so rotten that the wood could be crushed in the hand.

North America suffers as much as Europe from this pest. All down the New England Coast piles are attacked and destroyed. In this region two years forms the average life of a piece of submerged timber. Channel buoys are left in the water only six months in the year, then a new set is put in and the old one dried. The zone of the ship-worm's devastation is comparatively large. Wood is attacked between points well above low-water mark and points 10 or more feet below it. The hardest oak offers no more difficulty than the softest pine, and the toughest knots are traversed. Teak alone resists the attack.

The agent of this vast amount of damage much resembles a worm, but is a true mollusk. Its long, whitish body, tapering toward the posterior end, is found imbedded in a shell-lined burrow. Individuals of this species sometimes attain the length of 10 inches, are one-quarter inch in diameter. Such size, however, is rare, four inches being the average length.

The "head" end of the animal is covered with a white bivalve shell. This protects the vital organs of the little creature, and from its interior opening projects a short "foot" which is probably the instrument by which the burrow is dug and lined with its pearly coating. Two pallets shaped and fastened to the posterior end of the body, much as leaves are fastened to the stem, close the teredo's hole, and protect from attacks the soft portions of the animal. Between these two plates lie the siphon tubes — used for inhaling and exhaling water. Through the lower of these (bronchial) is drawn the water breathed by the animal, and likewise those minute animalcules which serve it for food. The dorsal tube serves as the organ of excretion. Through it passes a stream of vitiated water carrying along the fæces and the wood excavated. Surrounding both the pallets and the siphon tubes is a much wrinkled muscular band, by which the teredo adheres to its "burrow."

The appearance of the teredo burrow is very peculiar. Outwardly the piece of timber infested shows a number of very small holes. Inwardly it resembles nothing more than a Swiss cheese. The channels run in all directions, sometimes so close to each other that the wood separating them is as thin as paper. But between the holes there is always a partition, for the animals never interfere with each other. Their sense of hearing seems to enable them to tell when they are approaching the outside of the wood or are nearing another burrow and they turn aside. The holes are always lined with irregularly laid shell and they generally go with the grain. Like many other mollusca the teredo passes through a long series of complicated metamorphoses before arriving at full maturity. The eggs, from the beginning of the breeding season in May, are confined in the gill cavity. Here they have their first period of growth. From the gill cavity the embryos are discharged in the form of free-swimming animals covered with vibrating cilia or hairs, by which they swim. In this stage they are almost exactly like ciliated infusoria. Next they lose these locomotive filaments and develop a rudimentary bivalve shell. In the third stage their relation to other bivalves is apparent in their resemblance to the common mussel. They have a mantle and shell covering their entire body and another sort of cilia replaces those lost. This bivalve character is further accentuated by the development of a long foot used for creeping and by the appearance of eyes and organs for hearing. These eyes, however, disappear as the animal elongates and the locomotive cilia are lost. In this stage the young teredo, settling on some convenient piece of wood and starting with a hole about the size of a pin-head, begins his burrow, and enlarges it as he goes on, until he has reached his full growth.

The fact that the ship-worm does not use as food the wood it excavates, but simply passes it through its body, has much to do with the failure of many attempts to make wood teredo-proof by poisons. Up to date creosote and dead oils are the remedies which have given the best results. The piece of lumber to be so treated is first steamed. Next the air is exhausted and the poisonous or noxious compound is forced in under a pressure of 400 pounds to the square inch. Usually, however, this system fails of the desired result. At Christiania, timbers poisoned in this manner were found to be, three years later, quite riddled with teredo. In some instances, however, piles so treated have been known to remain free from ship-worms for as many as 15 to 20 years.

Although poisoned timbers are often used for such structures as government docks (which must be as permanent as possible), for ordinary piers and for submerged work, the expense of so treating the wood is generally greater than the cost of periodical renewal. Of course the most thorough defense would be one which prevented the entrance of the young animal. Copper-sheathed vessels are quite free from its attacks, while copper paint, creosote or coal tar frequently applied has the same effect. Piles may be defended by broad-headed nails closely driven, for the ship-worm seems to avoid entering any wood impregnated with iron rust.

A large species of teredo (*T. gigantea*), from Sumatra, has been found to measure from four to six feet, and to have a diameter of about three inches. It bores into the solid mud, and does not appear to destroy timber like its smaller neighbor. Consult Cooke, 'Mollusca' (London 1898); Verrill 'Invertebrates of Vineyard Sound' (Washington 1875).

TEREK, tĕ-rĕk', Russia, a river in Circassia, which rises in Mount Kasbek, at the north of the Caucasus, among icy glaciers. It follows a northwesterly course through a narrow valley, then turns east and after dividing into numerous branches enters the Caspian Sea by a delta. Its entire length is nearly 400 miles, only a small distance being navigable. The main tributaries are the Ardon, Uruch, Malka and Baskan on the left; the Sunsha, Assa and Argun, on the right. A series of small fortifications for protection against the mountain tribes are built along the river from Mosdok to the foot of the pass over the Great Caucasus, where the descent is made into Georgia.

TERENCE, tĕr'ĕns (PUBLIUS TERENTIUS AFER), Roman writer of comedies: b. Carthage, Africa, between 185 and 195 B.C.; d. probably in Greece, 159 B.C. While yet a child he was bought by Publius Terentius Lucanus, a Roman senator, who took him to Rome and gave him a good education. His master having emancipated him the young African now assumed the name of his benefactor. Lælius and Scipio Africanus (the destroyer of Carthage and Numantia) admitted him to their intimacy, and as some aver, assisted him in the composition of his plays. About the year 161 he went to Greece, where he is said to have translated 108 of Menander's (q.v.) comedies. Six comedies of Terence's alone are extant — the 'Andria,' the 'Eunuchus,' 'Heautontimorumenos,' 'Phormio,' 'Hecyra' and the 'Adelphi,' his last piece, brought out in Rome the year before his death. The comedies of Terence were much admired by the cultivated Romans for their exquisite style, the language of Cicero, Cæsar and the orators, and were likewise esteemed for their maxims and moral sentences. If we compare him with Plautus, his only important predecessor, we miss what Cæsar styled the "vis comica," that sparkling wit and humor which made Plautus the model of Molière. On the other hand Terence has the finer vein of sentiment, the more subtle power of characterization and the purer latinity. He was indeed the founder of polite comedy, the comedy of society in Europe and his influence has been felt throughout the whole history of literature. Most of his plays follow closely the originals of Menander, but from the fragments of Menander which remain they do not appear to be mere translations. The comedies of Terence have been translated into English by the elder Coleman and several others. (See ADELPHI). Consult The edition of Bentley (1726); Vollbehr (1846); Dziatzko (1884), and Conradt, 'Die metrische Composition der Comödien des Terentius' (1876).

TERESA, tĕ-rē'sa (Sp. tā-rā'sä) **Saint** (properly **Theresia**), Spanish conventional re former: b. Avila, Old Castile, 28 March 1515; d. Alba, 4 Oct. 1582. Her attention was drawn in childhood to lives of saints and martyrs and when she and her brother were children under 10 they set off into the country of the Moors in hopes that some infidel would seize and kill them on account of their faith and that they would thus obtain the crown of martyrdom. Defeated in their object they attempted to become hermits. Her father, a nobleman, Don de Cepeda, placed her, after the death of her devout mother, in a monastery of the Carmelites at Avila when she was 16 and though she lived for some years there without any of her early religious enthusiasm, a change came over her at 20 and she took the veil. Her new spirit of devotion was deepened by reading the 'Confessions of Saint Augustine' and being much distressed by the apparent decay of discipline which she saw around her, she founded in 1562 another convent at Avila, dedicating it to Saint Joseph and introducing a new order, the Discalced or Barefooted Carmelites, also called Teresians. She began by making this a genuinely mendicant order, but modified this detail of the rule in obedience to her superiors. From this mother house there sprang 16 other institutions of the same order. She spent the later part of her life in traveling from one to another of these branch houses and the staff, cross and rosary she wore on these pilgrimages are still preserved at Avila. She was seized with her last illness in the palace of the Duchess of Avila, but at her own request was carried to her convent of San José, where she expired surrounded by her followers. Gregory XV canonized her (1622) and appointed 15 October as her festival and Philip III declared her the second patron saint of the monarchy, Saint James (Santiago) being the first. This decree was confirmed by the Cortes in 1812. She also has a worldwide reputation as a mystic, and among the most famous books of devotion which the Roman Catholic Church can boast are her five works: 'Discourso o Relacion de Su Vida' (1562); 'El Camino de la Perfeccion' (1563); 'El Libro de las Fundaciones'; 'El Castillo Interior' (1577), and 'Santos Conceptos del Amor de Dios.' These have been translated into most of the languages of Europe. Consult 'Saint Theresa' (edited by Cardinal Manning, 1865); Graham, 'Santa Teresa' (1894); Jameson, 'Legends of the Monastic Orders'; Senonville, 'Sainte Thérèse et son Mysticisone' (1893); Joly, 'Saint Teresa' (1903); 'Vie de Sainte Thérèse, Ecrete par Elle-Même' (15th edition, edited by Jules Peyré, 1904).

TERHUNE, tėr-hūn', **Albert Payson,** American fiction writer, traveler and journalist: b. Newark, N. J., 21 Dec. 1872. He was graduated from Columbia in 1893 and in 1893–94 traveled on horseback through Syria, investigating leper settlements, living among the Bedouins, etc. He has been connected with the New York *Evening World* since 1895 and is an expert writer on historical topics. His publications include 'Syria from the Saddle' (1896); 'Dr. Dale: a Story Without a Moral' (with his mother, "Marion Harland," 1900); 'Caleb Conover' (1907); 'The Fighter' (1909); 'Dad' (1914); 'Damon and Pythias'; 'Columbia Stories'; 'Stories of the Superwomen'; 'The Woman' (1912); 'Dollars and Cents' (1915); 'The Years of the Locust' (1915), etc. He is originator and author of the New York *World's* famous Popular Educational Series that has been running in 50 American newspapers since 1906.

TERHUNE, Mary Virginia Hawes («Marion Harland»), American novelist and writer on domestic science: b. Amelia County, Va., 31 Dec. 1831. She began to write for the press when 14 and in 1856 was married to Edward Payson Terhune. She conducted *Babyhood,* for two years, established the *Home-Maker* in 1888, was a department editor on the staff of *Saint Nicholas* and *Wide-Awake* and later on the staff of the Philadelphia *North American.* Her novels have enjoyed a wide popularity and her cook-books and articles on household management are of practical value and extensively circulated. The latter include ‹Common Sense in the Household› (1872); ‹The Dinner Year-Book› (1877); ‹Marion Harland's Model Housewife›; etc. She was the originator of the movement to finish the monument over Mary Washington's grave and wrote in furtherance of her purpose ‹The Story of Mary Washington› (1892). Her other works include ‹Alone› (1854); ‹The Hidden Path› (1855); ‹Nemesis› (1860); ‹Husbands and Homes› (1868); ‹Loiterings in Pleasant Paths› (1880); ‹His Great Self› (1892); ‹More Colonial Homesteads› (1899); ‹Dr. Dale,› with her son, A. P. Terhune (1900); ‹Distractions of Martha› (1906); ‹Where Ghosts Walk› (1910); ‹The Long Lane› (1915), etc.

TERLINGUAITE, a native oxychloride of mercury, occurring in minute monoclinic crystals in the recently-discovered mercury deposits of Terlingua, Texas. It is transparent, has a sulphur-yellow color, brilliant adamantine lustre, hardness between 2 and 3, specific gravity 8.7. It is intimately associated with the other new mercury minerals, eglestonite and montroydite. See *American Journal of Science* IV, Vol. XVI, September 1903.

TERM, *in law,* (1) a limited or specific extent of time. (2) The time during which a court may legally transact business. In the United States terms vary according to the volume of judicial business and the available judges. (3) The time set for the payment of rents. (4) An interest or estate in land for a fixed time, as a year. If the term is for life it is a freehold and, therefore, treated as realty in law; if for years only, it is merely a personal interest and, therefore, personalty. (5) In Scots law, the period within which a party is compelled to produce evidence to support the allegations in his pleading.

TERMINAL MORAINE. See Moraine.

TERMINI IMERESE, Sicily, in the province of Palermo, 23 miles southeast of the city of Palermo, a seaport, on the northern coast, on a high and fertile point, near the San Leonardo River. It contains a museum, where are preserved antiquities of the ancient *Thermæ Himerensis,* founded 408 B.C., by the Carthaginians. Some ruins of the once-famous baths, as well as fragments of a theatre and an aqueduct, still exist. The chief products and exports include macaroni, corn, oil, olives, etc. There are important fisheries and good thermal saline baths. There is a school of navigation and a technical school, also a picture gallery. Pop. 21,000.

TERMINUS, a boundary stone or landmark, personified as the god who guards boundary lines and landed property. Jupiter was worshipped in Italy as Jupiter Terminus. The origin of this worship was attributed to Numa, who ordered that every one should mark the boundaries of his land by stones consecrated to Jupiter Terminus and should offer upon them every year at the festival of the Terminalia sacrifices of cakes, meal and fruit. This law also applied to the state, but the public termini were neglected in the later period of Roman history, while the termini of private property long retained their sacred character. A terminus stood in the temple of Jupiter in the capitol. On Roman coins a Terminus is represented like the Greek Hermæ, a square column surmounted by a head.

TERMITES, WHITE ANTS, or DUCK-ANTS, a family of insects composing the order *Isoptera,* which have a superficial resemblance to ants, though far removed from them in structure, being allied to the Mayflies. They also resemble ants in being social insects, living in colonies and building «nests» or «hills.» They are widely distributed in tropical countries, but also occur in the temperate parts of North and South America and a few have established themselves in Europe. Their food consists for the most part of wood, especially in a state of incipient decay, but they also eat a great variety of substances, including dead comrades and excrement. The termite society consists for the most part of wingless, sexually immature individuals, children, potentially of both sexes, which do not grow up. Besides these workers there is a less numerous caste of large-headed, blind, strong-jawed soldiers, but these are not so well differentiated as among the true ants. The workers collect food, form burrows and tunnels, build «hills» and care for the males, females, eggs and larvæ. The males and females have wings, which the latter lose after impregnation. Then, indeed, the female or queen undergoes a remarkable change, becoming enormously distended with eggs and sometimes attaining a length of two to five inches or more — «a large cylindrical package, in shape like a sausage and as white as a bolster.» As only the abdomen swells, the resulting disproportion between anterior and posterior parts is very striking. The queen is extremely prolific, having been known to lay 60 eggs in a minute or about 80,000 eggs in a day. In the royal chamber a male is also kept. It is hardly necessary to say that the queen could not leave if she would. But to understand this imprisonment we must notice that in spring the young winged males and females leave the nest in a swarm, after which pairing takes place; the survivors becoming the imprisoned «rulers» and parents of new colonies.

Fritz Müller has shown that besides the winged males and females there are (in many cases) wingless males and females which never leave the termitary in which they are born, being kept as complementary or reserve reproductive members, useful should not a winged royal pair be forthcoming. Sometimes this casualty occurs and then the wingless pairs become parents. The complementary kings die before winter; their mates live on, widowed, but still maternal, till at least another summer. Müller points out that, though the production and parentage of wingless males and females involves less mortality, the winged males and

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females probably cross with those from other nests, thus securing the advantages of cross-fertilization. The workers are diligent in tending the king and queen, in removing the laid eggs and in feeding the larvæ.

In general appearance and size a wingless termite is ant-like, but the winged forms are much larger and flatter and their wings are quite different. The workers have large, broad heads and strong jaws adapted for gnawing; the soldiers have still larger heads and longer jaws. Besides the jaws and the two pairs of maxillæ the head bears a pair of beaded antennæ, two eyes and two ocelli, but the workers and soldiers are blind. The thorax has the usual three segments and bears simple legs; the abdomen consists of nine segments.

The most remarkable termitaries are those of *Termes bellicosus*, abundant on the west coast of Africa and called "ant hills." They are sugar-loaf-like in shape, 10 to 20 feet in height, and, though built of cemented particles of earth, are strong enough to bear a man's weight. Internally there are several stories and many chambers, some for the workers, one for the king and queen, others for the eggs and young, others for storing supplies of compacted minced wood. But the termites do not all build such gigantic nests; although some build homes on the branches of trees, out of masticated woody material, which are larger than barrels.

In Africa *Termes bellicosus* and *T. arborum* are common species. A few species, all probably introduced, occur in Europe. In America only one species is known in the eastern United States, the almost ubiquitous *T. flavipes*, which does an enormous amount of damage by eating out the interior of beams and floors, in old houses; destroying furniture, boring galleries through and through stored books and papers and ruining many other articles in which their presence is not suspected until no more than a shell remains.

Bibliography.— Hagen, 'Monographie der Termitiden' in 'Linnæa Entomologica' (Vols. X–XIV, 1855–59); Fr. Müller, 'Beiträge zur Kenntniss der Termiten' in 'Jenaische Zeitschr. f. Naturwiss' (Vols. VII–IX, 1873–75); Grassi, 'Memoria sulla Società dei Termiti' (Accad. Lineei, Roma, 1892); Sharp, 'Cambridge Natural History' (New York 1895); Howard, 'Insect Book' (New York, new ed., 1914).

TERMS OF OFFICE. See ELECTORAL QUALIFICATIONS.

TERN, or **SEA-SWALLOW,** any of many small gulls (q.v.; also *Laridæ*) distinguished by the long, slender and straight bill and by the narrow nostrils, which exist at its base. The wings are long and pointed and the tail is forked. The common tern (*Sterna hirundo*) is a familiar visitant to North Atlantic coasts. It is a very active bird, seeming to have a ceaseless flight, and feeding upon small fishes. Its average length is 15 inches, the long forked tail constituting a considerable element in this measurement. The color is black on the head and neck and ashy gray on the upper parts generally. The under parts are white, the legs, feet and bill being red. These birds have, however, nearly disappeared from the eastern shores of the United States, owing to their ceaseless persecution in their breeding places by egg-hunters and plume-hunters. About 80 species of terns exist in various parts of the world.

TERNATE (tĕr-nä'tē) **ISLANDS.** See MOLUCCAS, OR SPICE ISLANDS.

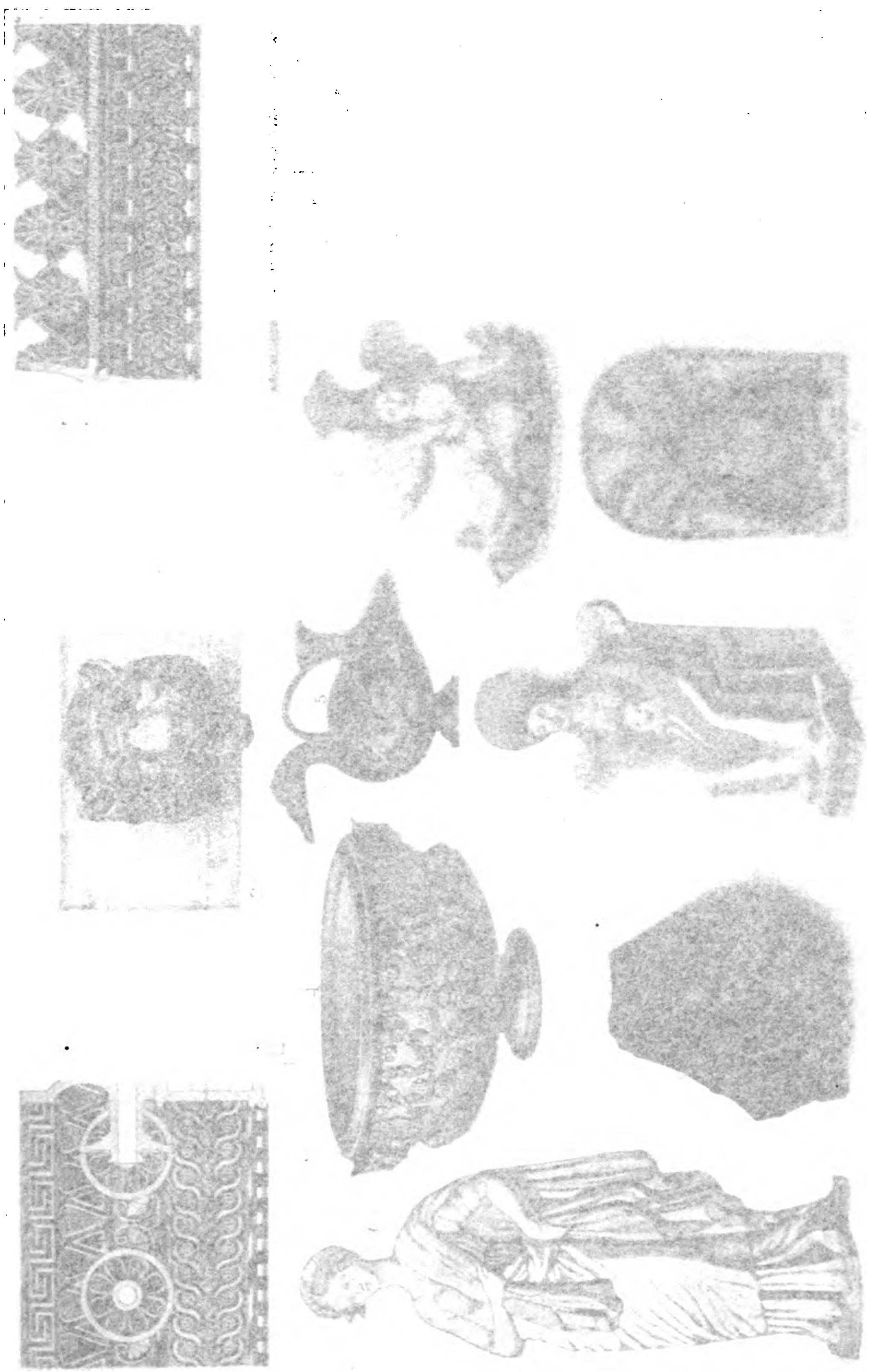
TERNI, tĕr'nē, Italy, in the province of Perugia, on an island, 50 miles north of Rome, in the midst of the Apennines, anciently known as Interamna. It is surrounded by the Nera River. The main buildings are the cathedral and other churches, convents and some Roman antiquities, chief of which is an amphitheatre. The celebrated falls or cascades of Velino or Terni near the city, 800 feet high, constitute the main attraction for visitors. They were constructed by the Romans to prevent inundations of the Velino River, by forming an outlet for the surplus water. Terni is a prosperous manufacturing town and it has important iron and steel works. The chief products of its works are silk and woolen goods, armor-plate, projectiles, steel castings, rails, guns, etc. This is the birth-place of Tacitus, the historian, and of the emperors Tacitus and Florian. Pop. 33,000.

TERPANDER, Greek musician: b. Antissa, Lesbos, 7th century B.C.; d. probably in Sparta. He was reputed to have gone to Sparta at the command of the Delphic Oracle. He was awarded the prize in the musical feasts of the festival of Apollo Carneius in 676 or 672 B.C. He is considered the founder of Greek classical music and was the originator of lyric poetry. He is reputed to have increased the number of strings on the lyre from four to seven, but this is probably an error, as evidence indicates an earlier date for that change. He was famous also as a teacher and a composer.

TERPENES, tĕr'pēns, a member of a class of hydrocarbons having the common formula $C_{10}H_{16}$, and found in the natural essential or ethereal oils obtained from a great variety of plants. They are usually liquids boiling between 340° and 375° F., of an aromatic odor and but slightly soluble in water. Two of the most important are pinene, the chief constituent of oil of turpentine, and limonene, which is found largely in the oils of orange, lemon, citron, bergamot, etc. Camphene is a solid terpene obtained by abstracting the elements of water from camphor. The camphors, two important examples of which are ordinary camphor and menthol, are oxygen derivatives of certain terpenes. See HYDROCARBONS.

TERPSICHORE, tĕrp-sĭk'ō-rē ("delighting in the dance"), one of the Muses, the originator and patroness of the art of dancing as accessory to the singing or recitation of lyrical poetry. She is generally represented with the lyre and plectrum, crowned with flowers and in a mirthful attitude.

TERRA ALTA, W. Va., city situated at the extreme western edge of the Allegheny plateau, 60 miles west of Cumberland, on the main line of the Baltimore and Ohio Railroad. It lies at an altitude of 2,500 feet, overlooking the beautiful Cheat River region, and is fast becoming a popular summer resort. There are two banks with combined resources of $1,100,000. The value of the city's taxable property is placed at $1,200,000. Its educational estab-



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Bibliography — [illegible] 'Monographie der Termiten' [illegible] Beiträge zur Kenntniss [illegible] Zeitschr [illegible] Grassi 'Mo[illegible] Termiti' (Accad. [illegible] Natural [illegible] New York, 1895); Howard, 'Insect [illegible] (New York, new ed., 1914).

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lishments comprise a public and a high school. The annual receipts and expenses of the municipality amount to about $7,500. Pop. 2,000.

TERRA BAIXA. See MARTA OF THE LOWLANDS.

TERRA COTTA, hard baked clay or earthenware of exceptionally good quality, of uniform texture, hard and durable. The 'English Dictionary of Architecture,' completed before there was much use in England of materials made with cement, speaks of it as artificial stone; but the term has also been used largely for that ancient earthenware of which are made the painted Greek vases which are so important in the history of art, and the inferior but still interesting pieces of Etruria. In common usage, however, the term is employed for such baked clay as is used in connection with architecture, whether in actual building, as where a hollow mass of the baked clay takes the place of a stone, or where a solid casting in the same material is used for molded string-courses and the like, in this way replacing bricks. It differs from brick in being harder, of better quality and molded to some special form or ornament.

Terra cotta is exposed without a coating of glaze or enamel, and its brown color constitutes the typical article. Japanese figures — groups, vases and the like — which were called «imitation bronze» when they were first brought to western countries are really terra cotta. They are often very beautiful in design, having the same vigor of modeling and perfect finish of all their parts which is found in the Japanese bronzes. The raku-yaki, that interesting brown ware which is used for tea-jars and tea-bowls and is the joy of the collector, is also a variety of terra cotta.

In the European Middle Ages terra cotta, unglazed, and also covered by a colored enamel, was used for roof tiles, and also for the much more elaborate pieces employed for crestings, and especially for those finials (in French *épis*) which are used where the hips of the roof meet the ridge and where in this way a salient point is produced. These finials often include the wind-vane which, however, would be commonly of wrought iron. The custom of using terra cotta in these ways lasted into the time of the revival of classic architecture, and some of the most interesting pieces are French of the 16th century; the custom not disappearing until the complete establishment of pseudo-classic uniformity of design throughout Europe. Chimney tops pierced with decorative openings through which the smoke might issue were also made of terra cotta and the custom still lingers in those simply built houses of Italy, Greece and Switzerland, where chimneys are built of hard baked earthenware tiles set in strong cement mortar and in this way made very light and thin.

Purely decorative pieces were also made of this material; but in the way of architectural adornment the most important development was in that Della Robbia ware (q.v.) which, however, is not often spoken of as terra cotta because it is covered completely by an opaque enamel which receives a most brilliant and effective polychromy, adding in this way color to sculpture in the most emphatic and interesting way known since antiquity. Still such pieces as the door-heads of many churches in Florence and elsewhere and the magnificent altar-backs; the lavabos or washing-fountains and the like throughout central Italy are among the most effective pieces to be found in that region. The most extensive and splendid work in Della Robbia ware is the broad frieze of the Hospital at Pistoja.

In the 18th century terra cotta, which had always been used by the French sculptors for the permanent form of many works of art, received a fresh impulse from the practice of Jean Antoine Houdon (q.v., see also UNITED STATES, SCULPTORS OF), Claude Michel (q.v.) (called Clodion) and others, among whom should be named certain makers of medallions as well worthy of study as the bronze medallions of the Italian Renaissance. In modern French practice portrait busts are very frequently made in baked clay, the same artistic quality being given them as to works in bronze or marble. The difficulty caused by the shrinking of the piece in the drying and subsequent baking is only to be met by extreme care in the selection and preparation of the material. The piece shrinks, but it may be made to shrink uniformly and without disturbing the symmetry.

Modern architectural terra cotta continually comes to the front as a material allowing of much richer treatment at a reasonable price than carved stone; but for some reason it never becomes very general in its application. A large business building in New York had its roof brackets or consols made of this material before 1855. The old Boston Museum of Fine Arts contained much decorative terra cotta brought from England and this front was completed about 1865. The constant demand for fireproof materials by means of which the exterior of a large building may remain without serious damage in spite of a hot fire across the street has made concrete, brick and terra cotta the obvious material for the facing; but stone, marble and granite still retain their places in many structures.

In making monumental figures, groups, designs, etc., of terra cotta the steps are: Mixing and kneading the clay; molding; retouching, for taking off any blemishes; baking; coloring and sometimes gilding. Modeling by hand is now rare, except in designing for a mold. The high grade work acquires its perfection largely by careful retouching. Baking requires to be performed slowly to permit evaporation of the moisture without injury. The coloring is mostly done after firing, solid body colors being employed, as browns, blues and reds, with occasional black or bright colors for sane detail. Some of the Roman terra cottas are in a fine state of preservation though dating back 2,000 or more years.

Within recent years there has been a marked increase in the use of terra cotta, often colored, for ornamenting steel and concrete buildings and for roof-tiles. Consult Strack, H., 'Brick and Terra Cotta Work During the Middle Ages' (Boston 1914); Walters, H. B., 'The Art of the Greeks' (London 1906) and the 'Annual of British School at Athens.'

TERRA DI LAVORO, tér-rä dē lä-vō'rō. See CASERTA.

TERRA VERDE, or **VERTE** (Italian «green earth»), a green mineral pigment used by painters in oil. A deposit of this earth is found in the neighborhood of Verona, Italy. There is a similar deposit in the island of Cyprus. The native green found in Italy is a silicious earth colored by protoxide or iron of which it contains about 20 per cent, and it is of extreme value as a permanent and brilliant tint in landscape painting.

TERRACES, successive benches or levels along the sides of valleys. A valley may show one or several terraces, varying greatly in height and in width. If composed of rock they are known as rock terraces. These may result from the presence of hard layers of flat-lying rock, as on the sides of the Grand Canyon of the Colorado. In other cases they are the results of successive uplifts, a narrower valley each time being incised within the broader older valley, leaving a remnant of the older valley bottom as the terrace. Alluvial terraces are composed of stratified gravel, sand or clay. Their history is usually more complex. After a given valley has been eroded, the first step is the filling of its basin with alluvium to some depth. This may be brought about by many causes. Particularly did it occur during glacial times, when the streams flowing away from the ice front were overloaded, filling their valleys with glacial outwash. Any cause which, after the valley is filled, will start the rivers to eroding, will obviously leave a gravel bench on one or both sides of the river. This renewed erosive activity may, in the case of glaciation, be merely the melting away of the glaciers, with the consequent return to normal conditions. It may be the result of uplift and rejuvenation of the streams, or it may result from climatic or other causes.

TERRACINA, tĕr-rä-chē'nē, Italy, in the province of Rome, on a gulf of the same name, near the Pontine marshes, about 18 miles northwest of Gaeta, and 56 miles southeast of Rome. It is a historical town lying on the Appian Way. It was sacked in 409 and again in 595. It is the see of a bishop and has a cathedral and handsome episcopal palace. The cathedral is built in the Italo-Byzantine style and incorporates the pillars of an ancient temple. Excavations have revealed the remains of a splendid temple of Venus. The main occupation consists in the fisheries. Pop. of the commune about 12,000.

TERRAPIN. See Diamond-back Terrapin; Turtles.

TERRAPIN, tĕr'ă-pĭn, a tortoise of the family *Emydidæ*. There are several different members of the family, all of which are fresh-water or tide-water. The name is also applied to the "elephant terrapin" of the Golapagos. Terrapin is held in great favor by epicures, especially in the United States.

TERRE HAUTE, tĕr'ē hōt (French, meaning "high land"), Ind., city, county-seat of Vigo County, on the Wabash River, and on the Chicago and Eastern Illinois, the Evansville and Terre Haute, the Evansville and Indianapolis, the Chicago, Terre Haute and Southeastern, and the Cleveland, Cincinnati, Chicago and Saint Louis railroads. It is 178 miles south of Chicago, 163 miles northeast of Saint Louis, 182 miles northwest of Cincinnati, and 72 miles west of Indianapolis. There are more than a dozen lines of railroads entering the city, two of which were built in 1905. It is one of the most prominent railroad and manufacturing cities of the Middle West. Terre Haute is one of the oldest settlements in the State; in 1816 it was laid out as a city, and in 1833 was chartered.

Topography.— The city is beautifully laid out on an elevated plateau, amid picturesque surroundings. It is connected with the west side of the river by several handsome railroad bridges, and for the use of the general public there was constructed a fine bridge (contract price, $27,000). There are several parks; the broad streets in summer time present a forest appearance. The residential part has many fine edifices in most beautiful surroundings.

Industries.— The city is in a rich agricultural region and in the centre of coal fields comprising over 2,000 square miles, containing a fuel supply which, at the present rate of consumption, will not be exhausted for 200 years. Coal is shipped from here to points within a radius of 400 miles, and it is a distributing point for about 1,500 carloads per day. The city is the industrial and commercial centre for a large portion of the western part of Indiana and the eastern part of Illinois. The manufacturing industries embrace rolling mills, foundries, distilleries, breweries, flour mills, hominy mills, car works, railroad shops, glass factories, stamping works, feed mills, tool works, fencing works and carriage factory. In the vicinity are large deposits of shale and clay and a number of clay plants are in operation nearby. In 1910 (government census) the total number of manufacturing establishments was 170; total capital invested in plants, $10,371,000; average employees yearly, 5,017; annual wages paid to employees, $3,219,000; cost of material used during year, $8,657,000; total annual value of products, $21,793,000. Owing to the failure of the natural gas supply in many places, there has been since 1910 an influx of manufacturing industries to take advantage of the cheap fuel and the railroad facilities. This accounts for the large increase in population.

Public Buildings.— The prominent public buildings are the government building, the county courthouse, city hall, opera house, the Union station, the schools, churches, charitable institutions, hotels and several business houses.

Charitable Institutions and Organizations. — The Rose Ladies' Aid Society cares for a large number of the poor, and has charge of the Home for Old Ladies. This home has an endowment of $100,000. The other institutions and organizations for the relief of the needy are Saint Anthony's Hospital (building cost $160,000), in charge of the Sisters of Saint Francis; Saint Ann's Orphan Asylum, in charge of Sisters of Providence; Rose Orphan Home, endowment, $200,000, building, $130,000; Union Hospital (Protestant), endowment, $25,000; Rose Dispensary, endowment, $200,000; and a number of church aid societies.

Education.— The educational institutions are the Indiana State Normal School, which annually enrolls over 1,000 pupils; the Rose Polytechnic Institute, founded by Chauncey Rose and opened in 1883; two high schools, 26 public elementary schools, Roman Catholic and Lutheran parish schools; Saint Joseph's

Academy (Roman Catholic); Saint Mary's of the Woods, a school for girls; a public library and libraries connected with the Normal School, and the Polytechnic Institute.

Banks and Finances.— The three national banks have a combined capital and surplus of about $2,000,000; one savings bank has deposits amounting to $1,700,000; and three loan and trust companies have capital and surplus of $1,205,000. The average annual cost for municipal maintenance and operation is $400,000. The public schools cost annually about $200,000; the police department $29,000; the fire department $40,500; for municipal lighting and streets $50,000.

Government.— The city is governed by a special charter granted by the legislature. The mayor and common council appoint or elect the administrative officials. The mayor appoints the boards of public works and public safety; the school board is elected by the council. The chief departments are fire, police, waterworks and municipal lighting. Pop. 75,000.

TERRELL, tĕr'ĕl, **Joseph Meriwether,** American politician: b. Greenville, Ga., 6 June 1861. He was admitted to the bar in February 1882, and in 1884 and 1886 was elected to the Georgia house of representatives. He was chosen United States Senator from Georgia in 1890, and was attorney-general for that State 1892–1900. He resigned in 1902 to accept the nomination for governor of Georgia, to which office he was elected in October of that year.

TERRELL, Tex., city in Kaufman County on the Texas Midland and the Texas and Pacific railroads, about 30 miles east of Dallas. It was settled in 1872 by Robert Terrell. It is an agricultural and stock-raising region, being one of the largest wagon cotton markets in the world. Chief manufacturing establishments are the Texas Midland Railroad shops, cottonseed-oil mills, cotton gins, cotton compresses, flour mills and factory for the manufacture of ladies' house dresses, sun bonnets and aprons. There is a large trade in wheat, oats, cotton, vegetables, fruits and livestock. The principal buildings are the North Texas Hospital for the Insane, schools, Carnegie Library, Elks Home, Federal building and city hall. There are eight churches. The educational institutions are the Texas Military College, a select training school for boys with both cavalry and infantry drill; two high schools (one for white and one for negro students), graded and ward schools and one private primary school. Three banks, with a combined capital of $600,000. The city has commission form of government, with initiative, referendum and recall features and government in hands of commission of five, one from each of the three wards of the city and two from the city at large, the functions of mayor being invested in the chairman of the commission. Commissioners elected for two years, two being elected one year and three the next. Pop. 8,500.

TERRES MAUDITES. See La Barraca.

TERRESTRIAL, or **CONTINENTAL, DEPOSITS,** those laid down on land in contrast to marine sediments laid down in the ocean. They may be alluvial, formed by rivers on flood plains; glacial, formed by glaciers; eolian, wind-blown material such as sand dunes; or lacustrine, laid down in lakes. Terrestrial deposits, like marine, may consist of gravels, sands and clays, forming conglomerates, sandstones and shales. Terrestrial limestones are rare, though they may form in swamps, or as wind-blown shell fragments, as the eolian limestones of Bermuda. Continental deposits are not likely to be as extensive or as regular in composition as marine beds, since the conditions under which they are formed are more variable. They are often marked by rain prints and sun cracks and by fossils of land plants and animals. See section on *Sedimentary Rocks,* in article on Rocks.

TERRESTRIAL MAGNETISM. See Magnetism.

TERRIER, the name of several small breeds of dogs. Terriers were originally used for unearthing the fox and for killing rats and other vermin, and several kinds are still employed in these and similar occupations. Some are good watch-dogs, and others are useful as retrievers. The most popular variety is the fox terrier, which came into fashion about 1863. It is generally white, with a smooth, dense, hard coat; its chest is deep and not broad; neck fairly long; nose black; ears small, V-shaped, pendulous. The maximum weight is about 20 pounds, and in accordance with a cruel practice the tail is frequently docked. There is also a wire-haired variety of the fox terrier. The bull terrier, for show purposes all white since 1860, is a larger animal produced by crossing a terrier with a bulldog. It has a long, tapering head, black nose, long and slightly arched neck, wide and deep chest, short, close, stiff, glossy coat and a comparatively short, tapering tail. The Boston terrier is a new and popular American breed, of great docility, kindness and quality. The Irish terrier, a trifle larger than the fox terrier, is of a reddish-yellow, wheaten or light-brown color inclining to gray, with a hard, wiry coat free from silkiness. Its chest is deep and medium wide; head long and flat; nose black; ears V-shaped and pendulous; neck long and slightly arched; and its tail usually docked and carried high. The Scotch terrier, a smaller animal, has a rather short, wiry, very dense coat of various colors, such as steel-gray, brindle or grizzled, black, sandy and wheaten. It has a tapering muzzle, black nose, small, prick or half-prick, sharp-pointed ears, short thick neck, broad and deep chest, uncut tail carried high with slight bend. The Skye terrier, the smallest of useful terriers, may be of any color. Its coat is double, the under part consisting of short, close, soft hair, and the outer part of long, hard hairs, free from curl or crisp. It has a long head, black muzzle, prick or pendent ears, deep chest, long and gently crested neck and short legs, and its tail may be carried either high or low. The Clydesdale or Paisley terrier is a kind of prick-eared, silky-coated Skye terrier. One of the modern varieties is the Welsh terrier, about the size of the fox terrier, with a close, wiry coat of a black-and-tan or black, grizzle and tan color. There is also an English white terrier, not unlike a small bull terrier. The Dandie Dinmont is a favorite small one, of a pepper or mustard color, with a moderately long coat consisting of hardish and soft hair mixed but without wiriness. Its large head is covered with soft, silky hair; nose black or dark; ears large and pendulous; tail of moderate length, with a regular upward curve. The Bedlington terrier is a slightly larger form, somewhat similar to the Dandie Dinmont. The black-and-tan or Manchester terrier has the head long, flat, tapering; nose black; ears small, V-shaped, hanging; neck long and tapering; chest narrow and deep; tail of moderate length, tapering; coat close, smooth, short, glossy; color jet-black and mahogany tan in different parts. He was produced by long years of skilful selection by the Manchester mill-hands of England, and is one of the smartest, pluckiest vermin-killers and most interesting pets on the list. The Schipperke resembles it, but is of German origin. One of the largest of the terriers is the Airedale, with pendulous ears, deep chest, high tail, hard and wiry coat, lying straight and close, and of a tan, black or dark grizzle color. The Yorkshire is the best known of the small top terriers. Consult Lee's 'Modern Dogs' (1896); Huntington, 'The Show Dog in America' (Providence 1901). See Dogs.

TERRIGENOUS, derived directly from the land, a term applied to those marine sediments like sands and clays, which are of direct land origin, as contrasted with pelagic deposits accumulating in the deep sea as the result of organic agencies, which extract their substance from solution in sea water. See section on *Sedimentary Rocks* in article on Rocks.

TERRITORIAL COURTS. See Court.

TERRITORIAL EXPANSION. See United States — Territorial Expansion of the.

TERRITORIAL WATERS. See International Law.

TERRITORIES, in the United States, certain parts of the national domain which have not been formed into States. Starting with 13 States it has been the policy of the United States in taking in new territory to require of the inhabitants evidences of fitness for self-government. This nation first added to its territory by the Louisiana Purchase, in 1803, 828,000 square miles. Florida and another territory to the total of 72,000 square miles were annexed in 1819; Texas in 1845; Oregon in 1846; the Mexican cession in 1848; Gadsden Purchase (30,000 square miles) in 1853; Alaska (591,000 square miles) in 1867; the Philippine and Hawaiian Islands in 1891; Guam and Porto Rico in 1898 and later (about 125,000 square miles); the Panama Canal Zone (436 square miles) in 1904; the Danish West Indies (now the Virgin Islands) of 142 square miles in 1917.

Of the above only the District of Columbia, Alaska and Hawaii are regarded technically as «territories.» The others that have not been granted Statehood are held as «possessions,» it having been decided by the United States Supreme Court in 1901, in the «Insular Cases,» that Congress can create appropriate forms of government in regions outside the States and legislate differently for such possessions.

The Philippines are at present governed by a commission of seven members appointed by the President. The commission is vested with the power of legislation and administration subject to the veto power of Congress. As yet no legislature has been established but the act of Congress passed in June 1902, under which the Philippines are now governed, provides that within two years following the date of the enactment of the said law, if a state of pacification exists in the island, an election shall be held for members of a legislative assembly of which the upper house is to consist of the members of the Philippine Commission. As soon as this is done the powers of local legislation now exercised by the Philippine Commission will pass to the legislative assembly. As yet no great degree of local self-government is allowed nor are the islands represented at Washington either by a commissioner or delegate. The inhabitants are not citizens of the United States and the determination of their political and civil status is left to Congress. The Samoan Islands and Guam are governed by military and naval governors, respectively. Of the unorganized domestic Territories Alaska has a governor, judiciary and other officers, appointed by the President, but has neither legislature nor delegate in Congress. A measure of local self-government has recently been allowed incorporated towns of 300 inhabitants. The District of Columbia is governed by three commissioners, two of whom are appointed by the President from civil life and the third is detailed from the engineer corps. They have general charge of the administration of the District, including the appointment of local officers. The law-making body, as in the case of Alaska and the Philippine Islands, is Congress, but the District has no delegate in the House of Representatives. Half the expense of governing is borne by the United States, the other half by residents.

Hawaii has obligated itself to incorporate the inhabitants into the American Union as soon as consistent with the principles of the Constitution. All the States thus far formed out of territory acquired from foreign nations except Texas and California have passed through the territorial stage. No general rule exists as to the period of pupilage through which the inchoate State shall be required to pass. In some instances, as in the case of Kansas, it has been as short as four years, while on the other hand Arizona and New Mexico after 60 years of territorial status were finally admitted as States. The nearest approach to a general rule is the requirement that the population of the Territory shall be as great as the ratio of representation in Congress, but this has often been disregarded, usually for political reasons. Thus Nevada was admitted for political purposes when its population scarcely exceeded 20,000, while Utah was refused admission long after its population exceeded the Congressional ratio. For a more detailed discussion of this subject see the articles on each separate State and Territory.

TERROR, Mount, Antarctic Regions, a volcanic mountain situated close to Mount Erebus (q.v.) on the coast of Victoria Land, in lat. 77° 30′ S. and long. 167° E. Its height is 10,883 feet. It was discovered in 1841 by Sir James Ross and named after one of his ships.

TERROR, Reign of, the period of the French Revolution extending from the downfall of the Girondists, June 1793, to that of Robespierre (q.v.), 27 July 1794. For an account of it see FRANCE — HISTORY B.C. 58 TO A.D. 1796.

TERROR, The White, the period of Bourbonist reprisals at the second Restoration. (See LOUIS XVIII). It was so called from the white flag (*le drapeau blanc*) of the Royalists. An «Edict of Amnesty» was published on 24 July 1815 but 57 were exempted from it — 19 to be tried by courts-martial on capital charges and 38 to be either exiled or brought to justice, as might be determined. In southern France there was rioting, assassination and pillage. This was especially true in Nismes and the surrounding region, where the victims were largely of the Reformed faith. The government was slow to intervene and the Allies were compelled to take matters into their own hands, a detachment of Austrian troops occupying the department of the Gard. In other districts there were similar outbreaks. Consult Vaulabelle, 'Histoire des Deux Restaurations' (1844 et seq.), and Daudet, L. M. E., 'La Terreur Blanche' (1878).

TERRY, tĕr'ĭ, **Alfred Howe,** American soldier: b. Hartford, Conn., 10 Nov. 1827; d. New Haven, 16 Dec. 1890. He was educated at Yale Law School and began practice in 1849. He had been a member of the State militia prior to the Civil War and at the call for volunteers he with his regiment, the 2d Connecticut, responded and was engaged in the battle of Bull Run. Being made a brigadier-general, he served in 1862–63 in the operations near Charleston. He commanded a corps in the Army of the James and fought at Chester Station, Drewry's Bluff and the siege of Petersburg and was entrusted with the military part of the second attempt on Fort Fisher, January 1865, co-operating with the admiral. The successful storming of the fort resulted in his being made a brigadier-general in the regular army. He captured Wilmington and was a departmental commander after the war. General Terry became major-general in 1886 and retired in 1888.

TERRY, Benjamin Stuytes, American educator and historian: b. Saint Paul, Minn., 9 April 1857. He was educated at Colgate University (A.B. 1878; A.M. 1881) and pursued theological studies at Hamilton and Rochester seminaries, resulting in his ordination as a Baptist minister 31 Aug. 1881. He occupied pulpits at Perry, N. Y. (1881–83) and at Fairport, N. Y. (1883–85). From 1885 to 1892 he was professor of history at Colgate University and took the degree of Ph.D. at Freiburg in the latter year. Directly thereafter he assumed the chair of English history at the University of Chicago. He is member of several historical societies and author of many historical articles in standard magazines. His best-known books are 'A History of England from the Earliest Times to the Death of Victoria' (1901) and 'A History of England for Schools' (1903).

TERRY, Charles Sanford, British historical writer: b. 1864. He was educated at Kings College school and Clare College, Cambridge, graduating B.A. 1886, and M.A. 1891. He lectured in history in several noted schools and was professor in the University of Aberdeen in 1898–1903. He became a well-known writer and authority on historical subjects, his best known publications being 'Life and Campaigns of Alexander Leslie, First Earl of Levin' (1899); 'The Rising of 1745' (1900; new ed., 1903); 'The Chevalier de Saint George' (1901); 'The Cromwellian Union' (1902); 'The Young Pretender' (1903); 'John Graham of Claverhouse' (1905); 'The Scottish Parliament' (1906); 'Craig's De Unione,' trans. with notes (1909); 'A Short History of Europe' (3 vols., 1911–15); 'Bach's Chorals' (2 vols., 1915); 'The Army of the Solemn League and Covenant' (2 vols., 1917). He also prepared catalogs of the publications of the Scottish historical clubs and an index of papers relating to Scotland.

TERRY, David S., American jurist: b. Todd County, Ky., 1823; d. Lathrop, Cal., 14 Aug. 1889. He served in the Texan War against Mexico under Gen. Sam Houston and in the war between the United States and Mexico; went to Calaveras County on the discovery of gold in California; and after some experience in mining studied law and began practice in Stockton. Elected an associate-justice of the California State Supreme Court in 1855, he became chief justice in 1857. He strongly opposed the procedure of the «vigilance committee.» In 1859 he killed Senator D. C. Broderick in a duel near San Francisco. Broderick had been an uncompromising opponent of the extension of slavery, particularly in Kansas, had taken active part in the bitter California campaign of 1859 and in one of his speeches made certain strictures resulting in a challenge. After service in the Confederate army during the Civil War Terry resumed practice in San Francisco.

TERRY, Ellen Alice, English actress: b. Coventry, Warwickshire, 27 Feb. 1848. Her parents were both actors and she made her first appearance at the age of eight, under the management of Mrs. Charles Kean at the Princess Theatre, London. A little later she won high praise as the young Prince Arthur in 'King John.' During the periods of 1860–63 and 1867–68 she acted with various stock companies, first appearing with Henry Irving in 1867, as Katherine to his Petruchio in 'The Taming of the Shrew.' She was married early in life to G. F. Watts, the painter, but the union was shortly dissolved, and she was married to E. A. Wardell in 1864, and again on 3 May 1907 to James Carew. She was absent from the stage 1868–74 and in 1875 won her first great success as Portia in a revival of 'The Merchant of Venice' at the old Prince of Wales Theatre. This she shortly followed with the title rôle in W. G. Will's play, 'Olivia,' the result being that Henry Irving made her his leading lady and the long artistic partnership at the Lyceum Theatre was commenced. Some of her impersonations at the Lyceum have been Ophelia, Portia, Desdemona, Juliet, Beatrice, Lady Macbeth, Cordelia, Margaret in Will's 'Faust,' the Queen in Will's 'Charles I,' Pauline in 'The Lady of Lyons,' etc. In company with Irving she has several times visited the United States and has been invariably successful. While still with Irving she joined Mrs. Kendal and Beerbohm Tree in a revival of 'The Merry Wives of Windsor' at Her Majesty's Theatre in 1902. She was honored by a jubilee performance at Drury Lane Theatre, London, in 1906. She published 'The Russian Ballet' (1913). Consult her autobiography, 'Story of My Life' (New York 1908).

TERRY, Henry Taylor, American lawyer: b. Hartford, Conn., 19 Sept. 1847. He was graduated from Yale in 1869 and was admitted to the bar in 1872. In 1878 he became professor of law at the Imperial University, Tokio, Japan, but returned to New York in 1884 and resumed practice the following year. In 1894 he again went to Japan and resumed his former position of professor of law. In 1912 he resigned his professorship and was made professor emeritus. He returned to the United States but did not resume active pratice. He is the author of 'First Principles of Law' (Tokio 1879); 'Leading Principles of Anglo-American Law' (Philadelphia 1884); 'The Common Law' (Tokio 1895), besides various articles in American and English legal journals. He received decorations from the emperor of Japan, the Order of the Sacred Treasure (II) and of the Rising Sun (III).

TERRY, Milton Spenser, Episcopal clergyman: b. Coeymans, N. Y., 22 Feb. 1840; d. 1914. He was educated at the Charlotteville Seminary and at the Yale Divinity School. He held various pastorates near New York between 1863 and 1884 when he was made head of the department of Hebrew and Old Testament exegesis and professor of Christian doctrine in the Garrett Biblical Institute at Evanston, Ill. Wesleyan University gave him the degree of S.T.D. in 1879; in 1871 he was made a member of the American Oriental Society and in 1883 of the Society of Biblical Literature and Exegesis. In 1881 he published 'Man's Antiquity and Language,' which was followed by a number of scholarly publications in steady succession, notably 'Biblical Hermeneutics' (1883); 'Sibylline Oracles' (1890); 'The New Apologetic' (1892); 'Biblical Apocolyphics' (1898); 'Moses and the Prophets' (1901); 'The New and Living Way' (1904); 'The Mediation of Jesus Christ' (1902); 'The Primer of Christian Doctrine' (1906); 'Biblical Dogmatics' (1907); 'The Shinto Cult' (1910); 'Baccalaureate Sermons and Addresses' (1914). He also published several Biblical commentaries.

TERTIARIES, tẽr'shĭ-ā-rĭz, members of the Third Order of various religious societies in the Roman Catholic Church. They are generally lay members of religious orders who follow ordinary avocations and duties in their communities, yet participate in certain work of a given order. Shortly after the institution of the Franciscan Order by Saint Francis of Assisi in the beginning of the 13th century, numbers of lay people were affiliated with the Franciscans under certain rules and restrictions, which bound them more systematically to a life of penance and devotion than ordinary persons living in the world. In the course of time many of these Tertiaries desired to take solemn vows, live in community and still follow the regulations of the Third Order. In this way rose various Tertiary congregations, which gradually united under the one government. Benedict XIII in the beginning of the 18th century recognized these Tertiary congregations and the laity affiliated with them as "a true and proper order, uniting in one seculars scattered all over the world and regulars living in community." Leo XIII recommended the Third Order in an especial manner to the faithful throughout the world, as a means of personal sanctification to be embraced by lay people who desired to lead a more devout life.

The Dominicans also had their Tertiaries, instituted by Saint Dominic himself, though in what year is uncertain. It was known as the Military Order of Christ, originally composed of knights and noblemen, whose duty it was to wage war against heretics. After the death of the founder this became the order of the penitents of Saint Dominic, for both sexes, and constituted the third order of Dominicans. These Tertiarians, without making any solemn vows, had the assurance of great spiritual privileges through the observance of a few fasts and prayers; they continued, also, in the enjoyment of their civil and domestic relations. Some few companies of Dominican sisters of the Third Order, particularly in Italy, united in a monastic life, and became regular nuns; the most celebrated of whom is Saint Catharine of Sienna. Other religious orders after the example of the Franciscans and Dominicans also established tertiary affiliations; the Augustinian hermits in the beginning of the 15th century, and later on the Minims, the Servites, the Carmelites and the Trappists. At the present time there are numbers of the laity throughout the world affiliated with the third orders and observing their regulations while still following their secular vocations in the world. See DOMINICANS.

TERTIARY PERIOD, the space of time, geologically considered, immediately preceding the present, and occupying the earlier and larger part of the Cenozoic era; also the rock system then formed. It is preceded by the Cretaceous. Tertiary strata were at first confounded with the superficial alluviums of Europe and it was long before their real characters were realized. They occur most generally in patches,—some of them of marine origin, others of fresh-water or of continental derivation. Rocks of this age were first described by Cuvier and Bronginart in 1810 from the Paris Basin, where they are well developed and highly fossiliferous. The shells found in these deposits were recognized as different from those of the modern time, though related to them, while the bones of quadrupeds were found to be of extinct species. Similar strata from many other parts of Europe were subsequently found. Those of Italy were found in low hills flanking the Apennines on both sides from the plains of the Po to Calabria and called by Basterot, who studied them, the Subapennines. The fossils of these beds were of a more modern type than those of Paris or London. In the neighborhood of Bordeaux, in the south of France, another series of Tertiary strata were discovered and described by M. de Basterot in 1825. The several hundred species of shells described from these beds were found to differ mostly from those of the Paris Basin and those of the Subapennines, and to possess an intermediate character between the two. Subsequently it was found that strata contemporaneous with those of Bordeaux overlie the Parisian formation in the valley of the Loire, and underlie the Subapennine beds in Piedmont.

In 1828 and 1829 Lyell conceived the idea that the Tertiary beds might be subdivided according to the percentage of living species in each. For this purpose, he and M. Deshayes, a well-known French conchologist, compared some 3,000 Tertiary with about 5,000 living species. The result arrived at was, that in the lower strata, or those of London and Paris, there were about 3½ per cent of recent species, in the middle Tertiary of the Loire, Bordeaux, etc., about 17 per cent of recent species and in the upper Subapennine Tertiary from 35 to 50 per cent of living species. These results were published in 1833. In formations still more modern, which Lyell studied in Sicily, where they attain a vast thickness, the percentage of living species was found to be 90 or 95. To these four series Lyell applied the names Eocene, Miocene, Older Pliocene and Newer Pliocene. A still later formation (Post-Tertiary) was called Pleistocene, in which the shells were all of recent types, but the mammals partly of extinct species. The most important recent modification of this nomenclature has been the introduction of the term Oligocene by Beyrish to include strata formerly classed partly as Upper Eocene and partly as Lower Miocene. The generally recognized divisions from the base up are now given as Eocene Oligocene, Miocene and Pliocene. At present much less stress is laid upon the numerical method of subdivision employed by Lyell and Deshayes. As the various deposits of the typical Tertiary beds of Paris, London, the Loire Basin and the Subapennine series became well known, a standard of comparison became established, by which similar deposits of other regions could be determined. This is the method employed to-day in deciding to which division a given deposit should belong.

The general characteristics of geography, vegetation and animal life of the Tertiary were similar to those of the present time, but land areas were of less extent and were more largely occupied by interior fresh-water basins. The climate of the early Tertiary was evidently warmer and more moist than that of the period following it, types of plants now strictly tropical then covering areas now under Arctic latitudes and influences. In the United States the Atlantic and Gulf costal plain underwent repeated submergence and emergence. During the first half of the period, the site of the Pacific Coast Ranges was largely under water, but in mid-Tertiary the Coast Ranges were upheaved, and the coast line took nearly its present form. The great western interior had undergone upheaval at the close of the preceding period (Cretaceous) in the formation of the Rocky Mountains. During Tertiary these underwent extensive erosion, building, on the great plains and in the intermontane basins, fairly thick beds of terrestrial gravel, sand and clay. A few lake deposits were also formed. Volcanoes were active during much of the period, from the Rocky Mountains westward, forming thick beds of ash and very extensive lava flows, as on the Columbia Plateau in Oregon and Washington. Marine Tertiary beds are found on the Atlantic and Pacific coasts. The most important of these are the strata of the Atlantic coastal plain with its expansion in the Gulf of Mexico. On the Atlantic Coast the Eocene beds are mostly clays and greensands which rest unconformably upon the Cretaceous strata and are unconformably overlain by the Miocene beds. All of these beds are highly fossiliferous, shells predominating. In the Miocene is a great bed of diatomaceous earth (q.v.) from 200 to 300 feet thick. In South Carolina, Pliocene beds make their appearance. No Oligocene strata are known from the Atlantic Coast. On the Gulf Coast the Eocene is well represented and rests upon the Cretaceous. It consists mainly of marls, greensands, clays and sands. Both Oligocene and Miocene are represented on the Gulf Coast. The Oligocene is characterized by a warm-water or subtropical fauna. The Miocene beds of the Gulf States represent the advent of the colder water fauna from the North. Pliocene beds of the age of those formed in South Carolina are extensively developed in Florida.

Tertiary deposits are well developed in the interior of the United States between the Mississippi River and the Rocky Mountains. They consist of non-marine strata, partly lacustrine, partly eolian and partly made up of wash from the mountain sides in the form of coarse alluvial cones or fans. In these deposits numerous bones of extinct mammalia are found, of which extensive collections have been gathered in the various museums of the country, particularly in the American Museum of Natural History in New York. Most of the deposits are in isolated basins, and can only be correlated by their vertebrate fauna. On the Pacific Coast, all the epochs of the Tertiary are represented, being in part marine, in part terrestrial.

Life of the Tertiary.—At the close of the Cretaceous period all the flying reptiles and dinosaurs, and most of the marine reptiles, seem to have become extinct; and the Tertiary formations, so far as known, yield only forms of *Vertebrata* essentially similar to those of the present day. Among fishes, all of the existing suborders and many of the existing families or even genera seem to occur in the Eocene. Among the invertebrates, ammonites, belemnites and most of the crinoids had passed away when the Tertiary era began; and forms came in, whose descendants are now familiar to us. The *Mammalia* suddenly appeared as the dominant type on all the continents and the evolution of many of the minor groups can be traced. Primitive tapirs and primitive horses, with four toes (*Orohippus* and *Eohippus*) occur. Among the Oligocene mammals may be mentioned the *Mesohippus*, or horse with only three functional toes. The peculiar *Oreodon* occurs in beds above the *Titanotherium* and represents a type intermediate between hog and deer in structure. Early camels, the earliest true carnivores, early bats, squirrels and rodents and marsupials also occur in these beds. *Miohippus*, a still more modified horse, occurs in the John Day and the Deep River beds; in the latter also occurs the oldest mastodon. In the Loup Fork beds occur *Procamelus*, *Mastodon* and dogs of the genus *Canis*. Consult Dana, 'Manual of Geology' (New York 1895); Zittell, 'Textbook of Paleontology' (New York 1900–04); Cope, 'Vertebrata of the Tertiary Formations of the West' (Washington 1884); Williams, 'Geological Biology' (New York 1895); Woodward, 'Vertebrate Palæontology' (London 1898, which contains an extensive bibliography). See CENOZOIC ERA; CHESAPEAKE STAGE; CLAIBORNE STAGE; EOCENE; MIOCENE.

CHARLES LAURENCE DAKE.

TERTIUS GAUDENS (Lat.), a diplomatic phrase meaning a mischief-maker; a third party who rejoices while two others are quarreling and hopes to profit by their dissensions.

TERTULLIAN (Quintus Septimius Florens Tertullianus), ecclesiastical writer: b. Carthage, c. 160; d. c. 250. The son of a pagan centurion in the proconsular service, he received a fine literary education and became as conversant with Greek as with Latin. He studied law and probably practised it, his writings disclosing intimate knowledge with juristic terms and methods. In early manhood (not later than the year 197) he was converted to Christianity by the admirable courage of the martyrs, although the precise date is not known. He was married, but this did not prevent him from being ordained priest, probably of the church at Carthage. About the middle of his career he publicly joined the Montanists and the vigor which he had displayed in defense of the faith against paganism was then displayed against the Church. Saint Jerome mentions certain affronts of the Roman clergy which may have provoked the fall of the great apologist. Since Tertullian was of a fiery nature, extreme and inclined to rigorism, the new prophecy (as Montanism was styled) with its severity in morals and in discipline had a natural and powerful attraction for him. But his restless spirit could not long be satisfied with Montanism and he became the leader of a separate sect, called after him Tertullianists. Tertullian was the most fecund, original and powerful genius in all the history of Christian Latin literature, which he in fact created. Nearly all of his works are of a polemic character and this brings out strikingly his penetrating intelligence, vast knowledge and inspiring eloquence. His style is energetic and concise, sometimes at the expense of clearness. Saint Jerome says that he is full of ideas but difficult to read. However, his works were seldom quoted until after the 16th century renaissance. It is not easy to draw a hard and fast line between Tertullian's Catholic and Montanistic works. To the years 197–198 belong the apologetic writings 'Ad nationes' (2 books), 'Apologeticum,' 'Ad martyres,' 'De testimonio animæ' and 'Adversus Judæos.' Other works of approximately the same period, but of less certain date, are 'De præscriptione hæreticorum,' 'De oratione,' 'De baptismo,' 'De pœnitentia,' 'De spectaculis,' 'De cultu feminarum,' (2 books), 'De idololatria,' 'De patientia' and 'Ad uxorem' (2 books). The Montanistic writings, including those tinged with Montanism as well as those wholeheartedly Montanistic, are 'De corona militis,' 'De fuga in persecutione,' 'De exhortatione castitatis,' 'De virginibus velandis,' 'Adversus Hermogenem,' 'Adversus Valentinianos,' 'Adversus Marcionem' (5 books), 'De anima,' 'De carne Christi,' 'De resurrectione carnis,' 'Adversus Praxean,' 'De pallio,' 'De pudicitia,' 'De monogamia,' 'Scorpiace,' 'De jejunio' and 'Ad Scapulam.' Tertullian's 'Apologeticum,' addressed about the year 197 to the governors of the provinces of the empire in favor of the Christians, if not the first of the Latin apologies in point of time (see FELIX, MARCUS MINUCIUS), is one of the first in the importance of its subject and its literary beauty. Some important works of Tertullian have been lost, notably the lengthy Montanistic work 'De ecstasi.' The Vienna 'Corpus script. eccl. lat.' contains an edition of Tertullian's works and the 'Ante-Nicene Library' contains translations of nearly all of his works.

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HERBERT F. WRIGHT,
Sometime of the Department of Latin, Catholic University of America.

TESLA, tĕz'lä, **Nicola**: b. in Smiljan, province of Lika, Austrian Croatia, in 1857; early education in Gospich; graduated from Real Schule, Karlstadt, in 1873; studied at Polytechnic School, Gratz, capital of Croatia, with the intention of becoming a professor of mathematics and physics, but became interested in electricity and took up and completed an engineering course. He afterward studied philosophy and languages at Prague and Budapest, keeping up meantime his electrical and engineering studies. For some time he was employed in the government telegraph engineering department as an assistant and while there invented several improvements which attracted notice. Then he became engineer for a large lighting company in Paris and next turned his attention to the United States as a promising field for electrical talent and experience. Here he formed a connection with the Edison Company at Orange, N. J., but gave up this engagement in order to be entirely free in his electrical work. He has made himself well known by his many practical inventions and the boldness and brilliancy of his ideas as to the possibilities of electrical science. These ideas, which have aroused widespread interest, have also in some degree diverted attention from the many useful contributions of Tesla to the world's fund of scientific achievement, most of which have been developed in the Tesla laboratory in New York, which he established for the purpose of independent electrical research.

Tesla's researches in electrical oscillation created a new field of electrical investigation, the full possibilities of which have by no means been exhausted. He was the first electrician to conceive an effective method of utilizing the undulating current, converting electrical into mechanical energy more simply, effectively and economically than by the direct current. He invented the modern principle of the rotary magnetic field, embodied in the apparatus used in the transmission of power from Niagara Falls. He has also invented many new forms of dynamos, transformers, induction coils, condensers, arc and incandescent lamps, the oscillator combining steam-engine and dynamo, etc. Consult Martin, T. C., 'Inventions, Researches and Writings of Nicola Tesla' (1894) and the files of electrical trade journals.

TESORETTO. See TREASURY, THE LITTLE.

TESS OF THE D'URBERVILLES, the best known of the novels of Thomas Hardy, was published in 1891. The sub-title, «A Pure Woman Faithfully Presented,» explains Hardy's thesis. Though technically guilty of an offense against society and ultimately hanged for the murder of her seducer, the heroine, Tess, is represented throughout as the victim of circumstance or, more exactly and more characteristically of the author, as the victim of a constant and malignant fate. This is personified in the brutal and emotional Alec D'Urberville, but it is also quite as destructive in the egoistic temperament of her husband, Angel Clare. The main point appears in the oft-quoted phrase in the last paragraph of the book, «'Justice' was done and the President of the Immortals (in Æschylean phrase) had ended his sport with Tess.» The tragedy, as in all of Hardy's more sombre stories, is intense and powerful. As in the best of the author's novels, there is the usual fully and delicately drawn background of local scenery and custom. The characters are carefully drawn and are vivid portraits of local types and individuals. The novel is rich in rural and farming scenes, of which the description in the second of the seven «phases» of the book is extraordinarily skilful and beautiful. On publication, 'Tess of the D'Urbervilles' attracted a great deal of attention by reason of its subject, the treatment of which was thought to be over frank and too searching an attack on conventions, but the literary and poetical skill of the author has been never better displayed than in the descriptions of customs, life and character.

WILLIAM T. BREWSTER.

TEST-PAPER, slips of unsized paper soaked in solutions of vegetable coloring matters, used as indicators of the presence of acids or of alkalis, and, in some instances, of special chemical compounds. The most common test-paper are litmus and turmeric papers; the former papers are colored with an aqueous solution of a blue substance obtained from various species of lichens, the latter with a solution in spirit of a yellow powder obtained by grinding the roots of a species of Curcuma cultivated in India and Java. Blue litmus is reddened by acids, the blue color being again restored by alkalis; turmeric is turned brown by alkalis. There are also pheno-phthalein and amido-benzol paper, which cannot be classed as vegetable coloring matters, though organic, while the use of papers soaked in inorganic compounds is not infrequent in analytical laboratories.

TESTAMENT. See BIBLE.

TESTICLE, one of the two genital glands of the male in which the spermatozoa and some other of the constituents of the semen are formed; a testis. The term is also applied to either of the posterior tubercles of the optic lobes or corpora quadrigemina. The testicle proper lies in the scrotum, is of an oval form and is mostly invested with a pouch or closed sac of serous membrane, the tunica vaginalis, derived from the peritoneum during the descent of the gland from the abdomen into the scrotum. The organ consists of a central portion or body, an upper enlarged extremity, the globus major or head, and a lower extremity, the globus minor or tail. Lying upon the posterior border of the testicle is a long narrow flattened body, the epididymis. To this border is attached the spermatic cord, composed of arteries, veins, lymphatics and nerves, connected together by areolar tissues and invested with fasciæ. This cord ends in the internal abdominal ring. It is accompanied by the vas deferens, the excretory duct of the testis (a continuation of the epididymis), which passes through the ring into the pelvis to the base of the bladder, where it unites with the duct of the vesicula seminalis to form the ejaculatory duct, which terminates in a slit-like orifice in the prostatic portion of the urethra. Underneath the tunica vaginalis is the tunica albuginea, or fibrous covering of the testicle, and beneath this coat is the tunica vasculosa, or vascular tunic, composed of a plexus of blood vessels held together by delicate areolar tissue. The glandular structure of the testis consists of from 250 to 400 lobules, each composed of from one to three or more minute convoluted tubes, the tubuli seminiferi. These tubules unite into larger tubes, which carry the seminal fluid from the testis to the epididymis.

The testicle is subject to hypertrophy, atrophy, injuries, acute or chronic inflammation, cystic diseases, fibroma, malignant disease and neuralgia. Inflammation of the testicle (orchitis), as that of the epididymis (epididymitis, q.v.), is usually attended with much pain and swelling and a feeling of weight and great discomfort. The use of a properly fitting suspensory bandage affords much relief; but the treatment of diseases or disorders of the testicle should be entrusted to a physician. (See also SPERMATOZOA). The removal of both testicles renders a man impotent — a eunuch. Castration is the surgical operation of removing the testicles, and is performed on horses, steers, etc., to render them more docile and tractable. It is generally recognized that castration reduces the will power and interferes with various brain functions.

TESTIMONY, in general, the evidence given by a witness orally in a legal proceeding; from the Latin *testimonium* (testimony); *testis*, a witness. It may be secured during a trial in court, or before a duly authorized commission. Although commonly so used «testimony» is not synonymous with «evidence» which is of broader significance and may include papers marked in a proceeding. Testimony is usually deduced through questions asked directly by counsel which may be followed by cross-examination and redirect examining. (See EVIDENCE). Consult Wellman, F., 'The Art of Cross-Examining' (New York 1903); Wrottesley, F., 'The Examination of Witnesses in Court' (London 1910, rev. ed.).

TESTIMONY, Psychology of. Applied psychology recognizes three groups of problems bearing on certain evidence in law. These deal with the report of a witness; the possibility of learning if he is concealing important facts; and the mental condition of the accused. Both lawyers and judges understand that differences in evidence given when both perception and memory are concerned do not necessarily imply dishonesty. Psychology shows that individual differences may be expected and that by carefully comparing the effect of such differences a fair amount of accuracy may be attained. By carefully questioning observers of an enacted scene it has been found that errorless reports are an exception, that a narrative form gives greater accuracy and that both range and accuracy in reporting increase with practice and may be thus made nearly perfect. The «reaction» experiment has given excellent results but still lacks perfection. If it is desired to learn whether the mind of a witness or accused person is normal, the usual mental tests may be applied with good success. See CRIMINOLOGY. Consult Gross, H., 'Criminal Psychology' (Boston 1911); Jung, C. J., 'The Association Method' (in *American Journal of Psychology,* Vol. XXI, Worcester 1910); Munsterberg, H., 'On the Witness Stand' (New York 1908); id., 'Psychology, General and Applied' (New York 1914); Whipple, G. M., 'The Observer as Reporter' (in *Psychological Bulletin,* Vol. VI, Baltimore 1909).

TESTING, in chemistry. See ANALYSIS.

TESTING MACHINES. Testing machines are employed to determine the physical properties of metals, and other materials such as cement, used for engineering and structural purposes. They are used especially in the testing of steel. The prime requisite of a material to be used in engineering operations is the property termed «strength,» which is its capability to withstand the action of forces that might be applied to it in various ways so as to produce tensile, compressive, bending, shearing and twisting strains. Very often the force applied is a combination of two or more of these strains or stresses, and the metal is called to withstand also the effects of abrasion or wear. Physical tests are of two general classes — those made to determine the suitability of a grade of material for a particular purpose, and those by which the effects of differences in chemical composition, and different methods of manufacture, on the properties of the material, are studied scientifically.

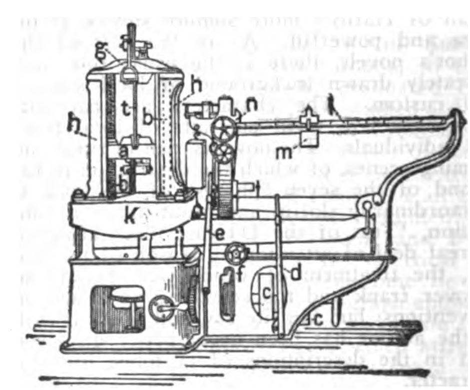
The most satisfactory method that may be employed for this purpose is to actually load a specimen of the material under test and gradually increase that load up to the breaking weight, and observe the effects thus produced. Such a method, however, is too slow and cumbersome, since the loads required for even the simplest commercial tests are very seldom less than 50,000 pounds, and loads ranging from 150,000 to 250,000 pounds are commonly used, and make the direct application of weight impracticable in most cases. Therefore, various machines have been devised by which any load, from the smallest that will perceptibly affect the specimen, up to the breaking load, may be readily applied and its weight accurately determined.

Of these three are two general types — those by which the specimen is loaded by means of a hydraulic press, and those employing a screw generally combined with a train of gearing.

The most perfect testing machine, for straining, rupturing or crushing pieces of metal, without injury to the machine, while exactly measuring or weighing the strains, is the Emery testing machine, which has frictionless hydraulic weighing heads, and is large and expansive of construction. It is used for government tests of important materials. Its disadvantages are due to the difficulty of keeping the heads filled with a suitable liquid, the difficulty of keeping the packing of the plungers in good order and the intermittent application of the load by the strokes of the pump.

In both types the load is applied in such a way that it acts through some form of weighing machine which enables the operator to determine instantly the weight of the load or the amount of the force being applied.

The general construction of the screw machine is shown by the accompanying illustration of the Riehlé machine, which may be readily used to subject a suitable specimen to any one of the three classes of strains — direct tension, direct compression and the transverse or bending, so that the weight of the load can be accurately determined.



Riehlé Testing Machine.

Referring to the illustration, the operation of the machine may be described as follows: The sliding head (a) may be moved up or down by the two screws (bb) which are operated by power derived from any convenient source and transmitted by belts on the pulleys (cc). These pulleys are loose on their shafts, and being provided with a cross belt on one and an open belt on the other rotate in opposite directions. The lever (d) actuates friction clutches which connect either of the pulleys with its shaft, so that the motion is communicated to the screws by gearing and thus raises or lowers the sliding head (a). By using the lever (e) and the hand wheel (f), the gears may be so combined as to give various speeds to the sliding head (a) as may be required in different classes of tests. The stationary head (g) is supported by columns (hh) which rest upon the platform (k) of the scale. The weighing beam (l) of the scale carries a movable counterpoise (m) which works on rollers along the beam. A hand wheel (n) operates a screw or chain which lies along the top of the beam and enables the operator to move the poise out along the beam gradually as the load is increased and thus observe constantly the weight of the load being applied. In some cases the poise may be arranged to be moved automatically by means of gearing operated by electrical connections, the circuit being made or broken by the action of the beam as it rises or falls.

In making a tensile test, the specimen is held between two pairs of jaws, one in each of the heads (a) and (g), as shown at (t). The head (a) is then drawn down by the screws, and the pull on the specimen presses the standards of the head (g) down upon the platform of the scales and causes the weighing beam to rise. In a compression test, the specimen is placed upon the platform of the scale and the sliding head is drawn down upon it. In a transverse or bending test, the specimen is placed on two supports carried by a heavy frame which is placed upon the platform of the scale, and the load is applied by means of a projection on the under side of the sliding head which presses upon the centre of the specimen when the head is drawn down.

Another machine of the screw type in extensive use is that built by Tinius Olsen. It is similar in principle to the Riehlé, but it employs four screws to operate the sliding head.

These machines are not only used to test metal specimens, but may also be used to test wood, cement and other classes of building material. In testing cement, small briquets of the material are made with a predetermined cross-sectional area at the centre and are then subjected to the tests as any other specimen.

In the testing of metals, the tensile test gives the simplest and most reliable data for determining the properties of the greatest interest in engineering operations.

TESTUDINATA, an order or sub-class of *Reptilia* (q.v.) containing the turtles or tortoises. See CHELONIA.

TESTUDO, among the ancient Romans a cover or screen which a body of troops formed with their oblong shields, by holding them over their heads when standing close to each other. This cover somewhat resembled the back of a tortoise, and served to shelter the men from missiles thrown from above. The name was also given to a structure movable on wheels or rollers for protecting sappers in undermining the defenses of an enemy.

TETANUS, a disease characterized by spasm of some or all of the voluntary muscles. The spasms vary in rigidity, and strong exacerbations attend their recurrence. Tetanus is a true toxæmia, and occurs in several varieties, the most familiar of which is lockjaw (trimus), whence it is commonly called by this name. The disease in all its forms (tetanus neonatorum, puerperal tetanus, idiopathic, traumatic and rheumatic tetanus) is caused by the tetanus bacillus, which was discovered by Nicolaier in 1884. Kitasato cultivated it in 1889. The bacillus is a slender rod, round-ended, existing in surface soil, dust, manure, etc., and as a rule occurring singly except in cultures. It lodges in some wound, often a slight and unnoticed wound, and the production of the disease is always a proof of its presence. Except in rare instances, the bacillus does not pass beyond the point of infection into the body. The real nature of the tetanus poison has not yet been determined, but its virulence is deadly in the extreme, and it is rapidly absorbed by the body in which it has found lodgment. It is carried through the body in the blood.

In milder cases the spasm of tetanus may be localized in certain muscles. Various theories regarding the action of the poison have been held by pathologists and the satisfactory explanation is still being sought by specialists in bacteriology and toxicology. Following childbirth, tetanus may infect both mother and child, and the average death rate from this disease, always high, is especially so among children. Surgical operations are sometimes followed by tetanus, but antiseptic surgery has doubtless lessened its frequency, and among diseases it is regarded as rare. Within about 10 days after an injury resulting in the infection, it sets in, the muscles at the back of the neck and those of mastication being usually first affected. The patient can neither masticate nor freely open his mouth. Often the progress to general rigidity of the muscles is very rapid, and convulsions of extreme violence ensue. Respiration is arrested, and death is often caused by this suspension. In other cases it results from spasm of the glottis, or from exhaustion produced by the violence of spasms.

There is no satisfactory treatment of tetanus, but such as physicians adopt is both local and general. Nothing is more important than careful cleansing of wounds, however slight, for precautionary purposes. Antitoxic disinfectants must be used, capable of destroying the poison produced by the bacilli as well as the bacilli themselves. Iodine solutions should be thoroughly applied to every tetanus wound. Potassium bromide, chloral, calabar bean, morphine and antimony produce good results, and opium and chloroform are employed for their quieting effects. Amputation is sometimes resorted to. Increase of fluids in the body by drinking or by intravenous injection, and corresponding increase of diuresis aid in eliminating the poison. Antitoxin serum (see SERUM THERAPY), prepared from the blood of the immunized horse, has proved a true remedy for tetanus, and many cures have been affected by its early administration. Preventive methods, especially those of inoculation, are now receiving the earnest attention of specialists. Consult Wallace, 'Indian Medical Record' (1891); Roux, 'Annales de l'Institut Pasteur' (1893); Bassano, 'Recherches experimentales sur l'origine microbienne du Tetanos' (1900); Moschcowitz, «Tetanus» in 'Annals of Surgery' (1900), Osler, W., 'Annals of Medicine' (New York 1915).

TETON MOUNTAINS, Wyoming, a very high and rugged granite range on the west side of Jackson Hole south of Yellowstone Park in the northwestern part of the State. The highest peak, Grand Teton, is 13,747 feet above sea-level. It is 17 feet higher than Fremont Peak and 38 feet lower than Gannett Peak of the Wind River range, the latter the highest point in Wyoming and the northern Rocky Mountain region.

TETRACHORD, *in music*, a scale-series of four notes. The word in its present use signifies a half of the octave scale. The fundamental system in ancient music was the tetrachord, or system of four sounds, of which the extremes were at the interval of a fourth. It was superseded by the hexachord. See MUSIC.

TETRADYMITE, a native bismuth telluride, often containing some sulphur and a trace of selenium. It occurs in pale steel-gray, metallic, foliated masses, in scales or more rarely in small rhombohedral crystals. It is soft enough to mark paper, its hardness being 1.5 to 2; while its specific gravity is high, 7.2 to 7.6. It occurs in Austria, Sweden and various localities in Virginia, North and South Carolina, Georgia, Arizona and Montana. It is also called telluric bismuth.

TETRAGRAMMATON, a Greek term meaning «the word of four letters,» and applied to the sacred Hebrew name of the Deity. It was considered improper to pronounce the divine name, and, therefore, an abbreviation of four letters was substituted, the most favored being «Y H W H,» which occurs 5,989 times in the Masoretic text of the Bible. The true name of God was uttered by the ancient Jewish priests only during worship in the temple. On the day of atonement the service required the high priest to pronounce it 10 times; but it was held to be impious to pronounce the sacred name promiscuously, hence this tetragrammaton «Y H W H» came to be pronounced by readers as Ya be, Iabe, Yave, Yahn, Iae, Yah, etc. For some reason it also became customary in reading aloud to say «Adonai» when the four letters occurred and this led to the substitution of Adonai for Y H W H. According to the best authority it should be pronounced as if written «Yahweh.» The letters of the tetragrammaton were made use of in various magic rites. Several illuminating articles on the names of God will be found in the Jewish Encyclopedia. Consult also Herzog-Hauck, 'Real-Encyclopädie' (Vol. VIII); Jacob, 'Im Namen Gottes' (Berlin 1903). Hence applied to other words of four letters expressive of a Godhead.

TETRAHEDRITE, or GRAY COPPER, a common and valuable ore of copper and silver. It is essentially a copper sulphantimonite, differing from tennantite into which it passes by insensible gradations only in the preponderance of antimony instead of the arsenic which distinguishes the latter. Its color and streak are usually steel gray; it often has a brilliant metallic lustre; its hardness varies widely from 3 to 4.5; its specific gravity is also quite variable, being from 4.6 to 5.1 in ordinary tetrahedrite, 4.5 to 5 in the argentiferous varieties (freibergite), 4.7 to 5.03 in the mercurial varieties (schwatzite). It crystallizes in the isometric system and owes its name to the fact that its crystals are invariably of tetrahedral habit. It occurs in fine specimens at many localities in Austria, Germany, England and Colorado, and is very widely distributed in massive form in copper and silver mines all over the world.

TETRARCH, tĕt'rärk or tē'trärk (Greek *tetrarches*), a term which meant the ruler of one-fourth of a country, but which was applied by the Romans to subordinate princes with small territories, especially in Palestine and other parts of Syria in the early years of Christianity. The two sons of Herod the Great, Philip and Herod Antipas, who received the lesser shares of his realm, were called tetrarchs, while Archelaus, who received the principal portion, had the title of ethnarch.

TETRAZZINI, Luisa, Italian soprano: b. Florence, 1874. While yet a child she learned perfectly several operas from hearing an elder sister (afterward wife of Campanini) practice them. She studied at the Liceo Musicale in Florence and after but three months training made her début in 'L'Africaine' in 1895, taking the part of 'Inez.' She afterward sang in several Italian cities and her continental successes were so great that she was called «the second Patti.» Finally she made such furor at Covent Garden that Oscar Hammerstein secured her in 1908 for the Manhattan Opera House in New York. Her operatic triumphs were continuous and she made a number of successful concert tours. As a singer she is noted for a voice of phenomenal power and great flexibility, coupled with unequaled ability as a coloratura soprano.

TETUAN, tĕt-oo-än', Morocco, a town on the northern coast of Africa, 33 miles southeast of Tangiers. It is defended by a castle. It is the only open port of the country on the Mediterranean, and lies a short distance south of Gibraltar. It is well built and many of the handsome private residences are the homes of Moorish exiles from Spain. The town is surrounded by fine vineyards, groves and orchards. The Hebrew merchants carry on a lively trade in fruit, wool, silk, girdles, leather and cotton. Provisions are exported to Ceuta. Pop. 25,000.

TETZEL, tĕt'sĕl, or **TEZEL, Johann**, agent for papal indulgences: b. Leipzig, about 1455; d. there, August 1519. He entered in 1489 the order of the Dominicans, and was ordained priest toward the end of the century. He soon began to appear in public as a preacher and gained a great reputation for his oratorical gifts. When in 1514 Leo X issued a bull granting an indulgence to all who would contribute to the building of Saint Peter's Church at Rome, Tetzel was selected to preach it in those provinces subject to the jurisdiction of the archbishop of Mainz. Luther came out in 1517 with his theses against this practice. These were answered by Tetzel and the students of Wittenberg burned the answers in the market place. Tetzel himself received a severe reprimand from the papal chamberlain, who was sent to settle the dispute, but was vindicated at Rome from the charges that had been brought against him. He died of the plague in the Dominican Convent at Leipzig. His life has been the occasion of much controversy owing to the part he took at the outbreak of the Reformation, but recent historical investigation has done much to rehabilitate his character. His life has been written by Hoffmann (1840); by Körner (1880), and on the Roman Catholic side by Gröne (1860) and Hermann (1883).

TETRYL. Tetryl is an explosive substance having the formula $NO_2.C_6H_2.N.CH_3.NO_2$, whose scientific name is tetranitrous thylaniline or preferably trinitrophenyline thylnitramine. Another common name in use for it is tetralite. It is prepared by dissolving dimethyl aniline in sulphuric acid and treating this solution with nitric acid. Pure tetryl looks like flour with a faint yellow tint. It fuses about 130° C. and solidifies at 128.7°. Its heat of formation is —40.8 calories. It is more powerful than TNT or picric acid but more sensitive than either. It is used as reinforcement in fulminate detonators, as the explosive core in detonating fuse, as a booster for high explosive shells and as a component of some ammonium nitrate explosives such as Fortex but is too costly for general use. It is somewhat poisonous, producing an irritation of the skin.

TEUFFEL, toif'fĕl, **Blanche Willis Howard,** Baroness von, American novelist: b. Bangor, Me., 21 July 1847; d. Munich, Germany, 7 Oct. 1898. She was educated in New York, but in 1878 she removed to Stuttgart, Germany, where she engaged in teaching and also edited for several years a magazine printed in English. She was married to Baron von Teuffel in 1890. Her publications include a book of travel, ‹One Year Abroad› (1877), and among her novels are ‹One Summer› (1875); ‹Aunt Serena› (1886); ‹No Heroes,› a story for boys (1893); ‹Seven on the Highway,› short stories (1897), etc.; and her works published posthumously are ‹Dionysius the Weaver's Heart's Dearest› (1899), and ‹Garden of Eden› (1900).

TEUTOBURGER WALD, toit'ō-boorg-ĕr vält, Germany, in Westphalia, a series of wooded hills, which begin on the left bank of the Diemel, near Warburg, and pass northward in the direction of Driburg, then northwest toward Örlinghausen, Bielefeld and Halle, finally Lengerich and Tecklenburg, and disappear in broken hills near Bevergern. Under the name of Egge they are steep and high and appear like a long wall; the highest point is Völmerstod (1,400 feet). There are, however, two lower parallel ranges. The second part is the Lippische Wald, also called Osning, believed by some authorities to be the real Teutobürger Wald. The third section includes the Ravensberg, Osnabrücken and Tecklenburg Mountains. The name is taken from Tacitus' annals, where an account is given of the defeat of the Roman general Quinctilius Varus by Arminius in the 1st century A.D. The Hermann monument on the Grotenburg commemorates this victory.

TEUTONES, tū-tō-nēz. See Germany.

TEUTONIC KNIGHTS, one of the three great military and religious orders which originated at the time of the Crusades. Its name was derived from a German hospital founded at Jerusalem in 1128. The Teutonic order adopted the Augustine rule of life, and, in addition to the ordinary monastic vows, the members took upon themselves special obligations to fight against enemies of the Christian faith, and to attend sick and wounded pilgrims. The order received charters from the Pope and the emperor entitling it to the same privileges as the Templars and Knights of Saint John. The distinguishing garb of the order was a white mantle with a black cross. The members were required to be Germans of honorable birth. Its first seat was at Acre, but it soon acquired, by gift and conquests, considerable territories in Germany, including a large part of what is now the kingdom of Prussia. When Prussia became a secular duchy the order continued to exist as an ecclesiastical body, possessing 11 bailiwicks in different parts of Europe, with a total area of 850 square miles, and 88,000 population. France seized the territories of the order, west of the Rhine, in 1801, and Napoleon suppressed the order in 1809, its lands being annexed to the states within which they were situated. About 1840 the order was revived in Austria, where it has since engaged in ambulance service in time of war. The bailiwick of Utrecht still exists, having survived the decree of Napoleon, but the Dutch representatives of the order have become Protestants. See Crusades; Germany; Prussia; Orders, Religious.

TEUTONIC LANGUAGES. The Teutonic, or Germanic, languages are unmistakably of a common origin. They comprise English, German, Frisian, Flemish, Dutch, Swedish, Danish, Norwegian, Icelandic and Gothic. The latter prevailed from the 4th to the 7th centuries A.D. over a large portion of the southwest and southeast of Europe, and in it we find the oldest written documents; however, both the Goths themselves and Gothic are now wholly extinct. German again includes both High and Low German, with their varying dialects, often differing very materially in their structure from each other. All these tongues, though deriving as they do from a common source, have differentiated greatly in historic times, so much so that most of them are quite unintelligible to the members of the other branches. Again, as far as written records are concerned, these date from very different periods. Thus, we know the Bible translation of Bishop Ulfilas (Wolf) of the Ostrogoths, parts of which in a fair state of preservation are kept in the University Library of Upsala, Sweden, and dating from the 4th century. This translation manifestly shows that Gothic even at that early time was a highly articulate language. Anglo-Saxon literature takes its rise in the 7th century, though some earlier fragments are probably incorporated in later works. The earliest German records date from the 8th and that of the Dutch from the 9th century. Frisian, a subdivision of certain very marked characteristics, does not become known to us by as much as a line till the 12th century, and in that century, too, the Scandinavian tongues for the first time make an appearance in preserved records, though it is not till the 15th century really that much of this is visible. Not until the last-mentioned period, either, do Swedish, Danish and Norwegian begin to contrast sharply in their interior construction and phonetics. Icelandic went its own course, on the other hand, being little influenced, by reason of geographical remoteness, by the cognate tongues further south. However, these northern idioms are at least rich in comparatively early inscriptions, in Runic characters, and afford much food to the philological searcher. Likewise both inscriptions and other early literary remnants discovered in the northern lands exhibit all the various stages of development, back even to a few types (like Icelandic), more archaic and rude than Gothic and dating from as early as the 3d century A.D. Moreover, some deductions as to the general style of the various early Teutonic dialects spoken by those tribes with whom the Romans came into contact from B.C. 150 to about A.D. 350 may be drawn from the proper names of the chiefs and other men of prominence, as these names were usually emblematic and compounded of descriptive adjectives or nouns, and these would show that on the whole during these 500 years the Teutonic vernaculars were fairly constant and not subject to rapid changes.

Certainly, the Germanic languages stand out clear and well-defined as a separate group of the Indo-European family, their nearest relationship being, in some respects, with the Italic and Celtic, in others with the Slavic tongues, and forming part of the western division. Most characteristic for the Teutonic idioms, from the philological point of view, is their manner of using the Indo-European explosive sounds. In some combinations consonants were lost or new consonants injected; *n*, for example, was eliminated before the *x*; final explosives and nasals were thrown out; their vowel system was in a general way a close assimilation to that of most other Aryan languages. The accent in the Teutonic tongues shifted, after remaining indeterminate for ages, to the first syllable. This must have been as early as about B.C. 100. Alliteration was employed a great deal, both in ordinary prose and in poetry, and this as far back as the time of the Cheruski, during the Augustean era of Rome. Alliteration also served to distinguish leading families or tribes from each other, the letter *s*, for instance, serving the Sigambri as a special mark of this nature. It was similar in the case of other Teutonic idioms. The phonetic characteristics, too, seem to have become fixed about the beginning of the Christian era. Dialectical differences existed even then, but were not nearly so pronounced as they have become since, a fact which the most ancient Runic inscriptions emphasize. On the whole, the Teutonic languages in their most primitive forms with which we are acquainted were more melodious, certainly richer in full vowels and not so overburdened with consonants as we find them now. Gothic, which at a very early stage became separated from the body of the language by reason of far wanderings and long-continued influences exercised on it by the adjoining and surrounding Latin and Greek populations, underwent a number of important euphonic changes. So much so indeed that after the lapse of some three or four centuries of this influence Gothic, as spoken both by Ostrogoths and Visigoths, as also by the Vandals, Gepidæ and other eastern Teutonic tribes, must have become scarcely intelligible to their kin who had remained on Germanic soil. This becomes reasonably certain by comparing the Bible translation of Ulfilas with contemporaneous specimens of German or Scandinavian. The latter two linguistic bodies, however, seem to have undergone their greatest internal alterations during the 6th and 7th centuries A.D. The vernacular of the Vandals, Gepidæ, etc., does not appear to have seriously differed from the Gothic. As for the chief parts of the early Germanic grammar, of the three numbers in vogue in Indo-European languages, the dual does not seem to have ever been used in the Teutonic idioms. Of the eight cases taken over from early Aryan, the vocative, the instrumental and the locative were made use of sparingly. As to the conjugation of verbs, the Teutonic system was simpler than in most of the Indo-European languages. The old Middle Voice is absent. In the early forms of the verb the Teutonic languages employ but two tenses, the present and the preterite; in lieu of the future a periphrase, a preposition or a perfective verb had to do duty. On the whole, therefore, it is undeniable that the Teutonic group of languages shows many peculiarities setting it apart from all others. Of course, side by side with those joint features set forth above, went on the process of individual development for each of the dialects and separate idioms, these growing at last into distinct languages. Most plainly this process of individualization may be observed in the comparatively rapid growth of the Scandinavian tongues. In the early Middle Ages the inhabitants of Scandinavia all spoke nearly alike and understood each other without serious trouble. Within the space of two centuries complete differentiation had been effected. In a sense, the Flemish and Dutch idioms show in their grammar forms an arrested development, due in a measure to political separation from the neighboring parent stock; in phonetics both differ very materially from the German.

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WOLF VON SCHIERBRAND,
Professor of German Language and Literature.

TEUTONIC ORDER, The. See ORDERS, ROYAL.

TEUTONIC RACE. See GERMANY.

TEWFIK PASHA, tū'fĭk păsh'ȧ, **MOHAMMED,** khedive of Egypt: b. 15 Nov. 1852; d. 7 Jan. 1892. He was declared heir apparent in 1866, when the sultan granted the right of primogeniture to the Egyptian reigning family, and in 1879 he succeeded to the throne on the abdication of his father, Ismail Pasha.

He was a ruler chiefly in name, the control of the government being virtually in the hands of foreign powers. A national party was formed of which Arabi Pasha, Minister of War, was at the head, and the friction between the khedive, who favored the English, and Arabi resulted in an insurrection in 1882. Through the intervention of England the uprising was quelled and a species of constitutional monarchy was adopted, giving an English financial adviser a place in the council in 1883. During the Mahdi troubles in 1884 Tewfik was forced to give up the Sudan. He was a man of simple tastes, married but one wife and was deeply interested in educational advancement and in the improvement of public works.

TEWKSBURY, Mass., town in Middlesex County, on the Boston and Maine Railroad, five miles south of Lowell. It has large horticultural interests, a chemical factory and contains the State infirmary. It was founded in 1654 and formed a part of the town of Billerica from which it was taken and incorporated 23 Dec. 1734, being named after the ancient town in Gloucestershire, England, famous for its abbey. Pop. 5,265.

TEXARKANA, tĕks-är-kăn'a, Ark., and Tex., twin city, one in Bowie County, Tex., the other the county-seat of Miller County, Ark., on the Saint Louis, Iron Mountain and Southern, Kansas City Southern, or «Port Arthur Route,» Saint Louis Southwestern, or «Cotton Belt Route,» Texas and Pacific, Texarkana and Fort Smith and the Memphis, Dallas and Gulf railroads, about 180 miles southwest of Little Rock, the capital of Arkansas, and 28 miles north of the Louisiana boundary. The cities are separated by the boundary between Texas and Arkansas, but they are one commercially, industrially and in all except the city governments. The name indicates unity; the first syllable is from the first syllable in Texas, the second from the first syllable in Arkansas, the last two from the last two syllables in Louisiana. Both the cities were settled in 1873; became incorporated towns in 1880 and cities of the second class in 1887. Texarkana, Ark., became a city of the first class in 1904. The post office serves for both cities and is designated as «Texarkana, Ark.-Tex.» The cities are in an agricultural and lumbering region and are an important distributing centre for a large extent of country. The chief industrial establishments are railroads and railroad shops, employing about 1,500 persons, lumber works, 500 employees, and other manufacturing establishments are numerous. Two large creosoting plants are near the city. Cotton and cotton products, lumber, grain and livestock are shipped from Texarkana in large amounts. The principal public buildings are the Government building, the Miller County, Ark., courthouse and jail, the Y. M. C. A. building, Railroad Hospital (cost $200,000), sanatoriums and the churches and schools. The United States court for the Western District of Kansas and United States court for the Eastern District of Texas, each hold annually two regular terms in the city within the district.

There are 31 churches, representing 17 different denominations. In each city are a high school, grammar schools, kindergartens and parish schools. Saint Agnes Academy, in Arkansas, was established in 1877; Saint Rose of Lima Academy is in Texas; Texarkana Industrial College opened in 1904. There are excellent banking facilities and good newspapers. The majority of the inhabitants are American born; about 650 foreign born and 4,200 of negro descent. Pop. (Ark.), (1890) 3,528; (1900) 4,914; (Tex.), (1890) 2,852; (1900) 5,256. Since 1900 the cities have grown considerably and the United States census of 1910 showed the population to be about 9,790; the 1918 estimate is 12,500.

TEXAS, the most centrally located of the southern tier of the United States, is much the largest in the Union and is popularly known as the «Lone Star State.» It is bounded on the southeast by the Gulf of Mexico, on the east by Louisiana, on the east and north by Arkansas, on the north and east by Oklahoma, on the west and north by New Mexico, on the southwest by Mexico. It lies between lat. 25° 51′ and 36° 30′ N. and between long. 93° 30′ and 106° 40′ W., and extends, therefore, east and west nearly 800 miles, north and south nearly 750. Its land area is 262,400 square miles and its coast line nearly 400 miles. According to United States census estimates it had a population of 4,700,000 in 1919 and a total wealth of $6,859,909,141 in 1912. Texas is divided into 252 counties and is a political but not a physical geographic unit. The State was admitted into the Union in 1845, having been for 10 years previously an independent republic.

Topography.— The general surface slopes upward fairly uniformly toward the northwest from sea-level to 4,000 feet and more. The Gulf deepens but slowly off shore and long barrier islands enclose along most of the coast shallow lagoons and bays whose total area is about 3,500 square miles. Padre, Galveston and Matagorda islands and Matagorda Peninsula are the longest of these barriers. Dredged channels aided by jetties allow large vessels to enter Galveston and Corpus Christi bays and Sabine Lake. The southeastern and eastern third of the State is quite flat but is diversified by very low hills along its northwestern boundary which rises to 500 or 600 feet above sea-level and which is marked toward the south by the Balcones Scarp and toward the north by the White Rock Scarp. The middle third of Texas is mainly level or nearly level country, but is marked by numerous hills which, chiefly in the southwest, cluster thickly enough to make large areas of rather rough contour. Except for the Trans-Pecos region west of the Pecos River, the northwestern third of Texas, rising northwesterly from about 2,000 feet on the east to 4,000 feet on the west, is a part of the almost level great plains, but is cut more or less toward the east by the head streams of the larger rivers. West of the Pecos and nearer the Rio Grande, upon a plateau with an altitude of 3,000 to 4,000 feet, rise the Guadalupe, Franklin, Quitman, Davis, Organ, Chinati, Chisos and other mountains. Two peaks considerably exceed 8,000 feet and 18 are higher than any east of the Mississippi. The mean elevation of Texas is 1,700 feet.

Rivers.—As a consequence of the northwesterly rise all the rivers flow in a general southeasterly direction. The Canadian and the Rio Grande, with its tributary, the Pecos, rise in the Rockies outside Texas. The Red, the Brazos and the Colorado rivers rise on the Staked Plains. The Sabine, the Neches and the Trinity rise in the northeast, the Guadalupe, the San Antonio and the Nueces rise in the central part of the State. The Canadian and the Red rivers are parts of the Mississippi River system. The other rivers discharge into the Gulf along the Texas coast, all except the Brazos emptying into bays which they are silting up. Owing to slight and irregular rainfall over their upper drainage areas, the larger rivers are not well adapted to navigation, nor do the streams in general afford much constant water power. The Rio Grande divides Texas from Mexico, the Red and Sabine rivers dividing Texas partially from Oklahoma, Arkansas and Louisiana.

Geology.—Archeozoic rocks are represented only in the Llano, Van Horn and El Paso regions where, and in the Marathon region, limited exposure of Cambrian and Ordovician strata are to be found. Scarcely any Silurian and no certain Devonian rocks have been discovered. In north central Texas, Carboniferous strata estimated to contain 8,000,000,000 tons of bituminous coal and a vast quantity of recently discovered petroleum outcrop over an area of 13,500 square miles. West of the coal-bearing area the Permian Red Beds outcrop over 25,000 square miles. The Jura-Trias system is unimportant, outcropping only along the scarps of the Staked Plains. In the Trans-Pecos region are lesser outcrops of the Carboniferous, Permian and Jura-Trias. Exception being made of the Llano region and the Permian-Carboniferous areas, the middle third of Texas from the Rio Grande to the Red River is covered by Upper and Lower Cretaceous areas in the proportion of two to five. The long Balcones Scarp marks a fault which divides the Upper Cretaceous on the east from the Lower on the west. The Eocene and Pleistocene, separated by a narrow Oligocene and a Miocene-Pliocene strip, occupy all of southern and eastern Texas in about equal areas. West of the Lower Cretaceous and the Permian outcrop, northwestern Texas is almost wholly occupied by later Cenozoic strata. Eruptive lava sheets are to be found in the Trans-Pecos, where the mountains are of the Basin Range type; basaltic outbursts are to be found widely but sparsely scattered through the southern Upper Cretaceous. In the Llano region vast masses of granite are exposed. Some 23,000,000,000 tons of lignite are estimated to lie in the Eocene Beds. The marine Neocene of the Coastal Plain contains immense petroleum deposits, but petroleum has also been found in large quantities in the Eocene, Cretaceous and even the Carboniferous. Over a thousand square miles of the Eocene are some easily accessible beds of good limonite.

Climate.— The lines of equal rainfall run nearly north and south, the rainfall diminishing from 55 inches in the east to less than 10 inches in the west. The average for the State is not far from 33 inches. Wide variations from annual averages are common and very wide departures from monthly averages are almost the rule. Evaporation steadily increases from 45 inches at the east to 90 inches at the west. Obviously Texas ranges from humid to arid. Eastern Texas has about 60 per cent, western Texas over 70 per cent of the possible sunshine. The mean annual temperatures range from 55° (35° in winter, 75° in summer) in the extreme north (Panhandle country) to 72° (60° in winter, 84° in summer) in the extreme south. Over most of southern and eastern Texas the mean summer temperature is about 81°. Temperatures of 95° are not infrequent, the Texas extremes being 115° and —16°. In winter the mean temperatures at Amarillo and Brownsville differ by 24°, in summer by 9°. High temperatures are much modified by the high evaporation and by the Atlantic trade winds, which blow regularly through the summer but are frequently interrupted in winter by the oppositely directed northers which blow with great violence, sending the temperature down sometimes as much as 50° in a few hours. Snow and freezing occur along the coast only during the severer northers and last only a day or so. The climate on the whole is quite healthful.

Flora.— The large size, varied rainfalls and temperatures of Texas unite to produce a wide variety of plants and animals. A trace of the Canadian Life Zone is to be found on the tops of the highest western mountains, surrounded lower down by more abundant specimens of the Transition Zone. The Staked Plains, a narrow and irregular strip extending southeast to Kerr County, and most of the Trans-Pecos above 4,000 feet are in the Upper Sonoran Zone. The remaining nine-tenths of the State is in the Lower Austral (cotton producing) Zone. The western and larger half of the Lower Austral is Lower Sonoran, the rest is Austro-riparian. There is a semi-tropical Gulf Strip of the Lower Austral as well as arid and semi-arid areas in the Lower Sonoran. Cypress, tupelo, palmetto, hickory, magnolia, gums, oaks, osage orange, sycamore, willow, long, short and loblolly pine abound in eastern Texas. Elms, pecans, cottonwoods and willows along the streams with oaks, cedars, hackberries and mesquite elsewhere characterize the rest of Texas east of the treeless areas. Many species of cacti, especially the prickly pear, grow in the Lower Sonoran area. Wild flowers abound in species and individuals. The various native grasses largely support the great livestock industry.

Fauna.— Prairie dogs, jack-rabbits, cottontail rabbits, skunks, rats and mice and opossums are the commoner animals. The coyote is still not rare and deer, protected by law, are maintaining their numbers. The wild buffalo is extinct and the antelope, bear, panther and peccary are nearly so. Armadilloes are common in the south. A great majority of the North American species of birds have been found in Texas. Characteristic and common birds are the scissortailed fly-catcher, mocking bird, lark finch, red bird, meadow lark, swallows, doves, quails and turkey buzzards. The wild turkey is now rare. Thirty varieties of lizards and 30 of snakes are known. The horned toad is the most interesting lizard. Poisonous rattle-snakes, moccasins and coral snakes and the harmless garter, black, pilot, coachwhip and bull snakes are widely distributed. There is a remarkable variety of fish in the lower coastal streams where small alligators are still fairly common.

TEXAS.

Estimated population, 4,429,566

COUNTIES

Pop.		
29,650	Anderson	L 3
975	Andrews	E 2
17,705	Angelina	M 3
2,106	Aransas	K 6
6,525	Archer	I 1
2,682	Armstrong	C 2
10,004	Atascosa	I 6
17,699	Austin	K 5
312	Bailey	E 1
4,921	Bandera	H 5
25,344	Bastrop	J 4
8,411	Baylor	H 1
12,090	Bee	J 6
49,186	Bell	J 3
119,676	Bexar	I 5
4,311	Blanco	I 4
1,386	Borden	F 2
19,013	Bosque	J 3
34,827	Bowie	M 1
13,299	Brazoria	L 5
18,919	Brazos	K 4
5,220	Brewster	D 5
2,162	Briscoe	C 2 and F 1
...	Brooks (Pop. incl. in Hidalgo, Starr and Zapata Cos.)	B 6
22,935	Brown	I 3
18,687	Burleson	K 4
10,755	Burnet	I 4
24,237	Caldwell	J 5
3,635	Calhoun	K 6
12,973	Callahan	H 2
27,158	Cameron	C 7
9,551	Camp	M 2
2,127	Carson	C 1
27,587	Cass	M 1
1,850	Castro	B 2 and E 1
4,234	Chambers	M 5
29,038	Cherokee	L 3
9,538	Childress	D 2 and G 1
17,043	Clay	I 1
65	Cochran	E 1
6,412	Coke	G 3
22,618	Coleman	H 3
49,021	Collin	K 1
5,224	Collingsworth	D 2
18,897	Colorado	K 5
8,434	Comal	I 5
27,186	Comanche	I 3
6654	Concho	H 3
26,603	Cooke	J 1
21,703	Coryell	J 3
4,396	Cottle	G 1
331	Crane	E 3
1,296	Crockett	F 4
1,765	Crosby	F 1
...	Culberson (Pop. incl. in El Paso Co.)	C 3
4,001	Dallam	A 1
135,748	Dallas	K 2
2,320	Dawson	F 2
3,942	Deaf Smith	A 2
14,566	Delta	L 1
31,258	Denton	J 1
23,501	Dewitt	J 5
3,092	Dickens	G 1
3,460	Dimmit	H 6
5,284	Donley	C 2
8,964	Duval	I 7
23,421	Eastland	I 2
1,178	Ector	E 3
3,768	Edwards	G 4
53,629	Ellis	K 2
52,599	El Paso	B 3
32,095	Erath	I 2
35,649	Falls	K 3
44,801	Fannin	K 1
29,796	Fayette	J 5
12,596	Fisher	G 2
4,638	Floyd	F 1
5,726	Foard	H 1
18,168	Fort Bend	L 5
9,331	Franklin	L 1
20,557	Freestone	K 3
8,895	Frio	H 6
1,255	Gaines	E 2
44,479	Galveston	M 5
1,995	Garza	F 1
9,447	Gillespie	I 4
1,143	Glasscock	F 3
9,909	Goliad	J 6
28,055	Gonzales	J 5
3,405	Gray	C 1
65,996	Grayson	K 1
14,140	Gregg	M 2
21,205	Grimes	L 4
24,913	Guadalupe	I 5
7,566	Hale	F 1
8,279	Hall	C 2 and G 1
15,315	Hamilton	I 3
935	Hansford	C 1
11,213	Hardeman	H 1
12,947	Hardin	M 4
115,693	Harris	L 5
37,243	Harrison	M 2
1,298	Hartley	A 1
16,249	Haskell	H 1
15,518	Hays	I 5
3,170	Hemphill	D 1
20,131	Henderson	L 2
13,728	Hidalgo	B 7
46,760	Hill	J 3
137	Hockley	E 1
10,008	Hood	J 2
31,038	Hopkins	L 1
29,564	Houston	L 3
8,881	Howard	F 2
.....	Hudspeth (Pop. incl. in El Paso Co.)	B 3
48,116	Hunt	K 2
892	Hutchinson	C 1
1,283	Irion	G 3
11,817	Jack	I 1
6,471	Jackson	K 5
14,000	Jasper	N 4
1,678	Jeff Davis	C 4
38,182	Jefferson	M 5
....	Jim Hogg (Pop. incl. in Brooks Co.)	B 6
....	Jim Wells (Pop. incl. in Nueces Co.)	I 7
34,460	Johnson	J 2
24,299	Jones	H 2
14,942	Karnes	J 6
35,323	Kaufman	K 2
4,517	Kendall	I 4
2,655	Kent	G 1
5,505	Kerr	H 4
3,261	Kimble	H 4
810	King	G 1
3,401	Kinney	G 5
....	Kleberg (Pop. incl. in Nueces Co.	J 7
9,625	Knox	H 1
46,544	Lamar	L 1
540	Lamb	E 1
9,532	Lampasas	I 3
4,747	La Salle	H 6
26,418	Lavaca	K 5
13,132	Lee	K 4
16,583	Leon	K 3
10,686	Liberty	M 4
34,621	Limestone	K 3
2,634	Lipscomb	D 1
3,442	Live Oak	I 6
6,520	Llano	I 4
249	Loving	D 3
3,624	Lubbock	F 1
1,713	Lynn	F 2
13,405	McCulloch	H 3
73,250	McLennan	J 3
1,091	McMullen	I 6
10,318	Madison	L 3
10,472	Marion	M 2
1,549	Martin	F 2
5,683	Mason	H 4
13,594	Matagorda	K 6
5,151	Maverick	G 6
13,415	Medina	H 5
2,707	Menard	H 4
3,464	Midland	E 3
36,780	Milam	J 4
9,694	Mills	I 3
8,956	Mitchell	G 2
25,123	Montague	J 1
15,679	Montgomery	L 4
561	Moore	B 1
10,439	Morris	M 1
2,396	Motley	G 1
27,406	Nacogdoches	M 3
47,070	Navarro	K 3
10,850	Newton	N 4
11,999	Nolan	G 2
21,955	Nueces	J 7
1,602	Ochiltree	D 6
812	Oldham	A 1
9,528	Orange	N 4
19,506	Palo Pinto	I 2
20,424	Panola	M 2
26,331	Parker	J 2
1,555	Parmer	A 2 and E 1
2,071	Pecos	E 4
17,459	Polk	M 4
12,424	Potter	B 1
5,218	Presidio	C 4
6,787	Rains	L 2
3,312	Randall	B 2
392	Reagan	F 3
....	Real (Pop. incl. in Edwards Co.)	H 5
28,564	Red River	M 1
4,392	Reeves	D 3
2,814	Refugio	J 6
950	Roberts	C 1
27,454	Robertson	K 3
8,072	Rockwall	K 2
20,858	Runnels	H 3
26,946	Rusk	M 2
8,582	Sabine	N 3
11,264	San Augustine	M 3
9,542	San Jacinto	L 4
7,307	San Patricio	J 7
11,245	San Saba	I 3
1,893	Schleicher	G 4
10,924	Scurry	G 2
4,201	Shackelford	H 2
26,423	Shelby	M 3
1,376	Sherman	B 1
41,746	Smith	L 2
3,931	Somervell	J 2
13,151	Starr	B 6
7,980	Stephens	I 2
1,493	Sterling	G 3
5,320	Stonewall	G 2
1,569	Sutton	G 4
4,012	Swisher	B 2 and F 1
108,572	Tarrant	J 2
26,293	Taylor	H 2
1,430	Terrell	E 5
1,474	Terry	E 1
4,563	Throckmorton	H 2
16,422	Titus	M 1
17,882	Tom Green	G 3
55,620	Travis	J 4
12,768	Trinity	L 3
10,250	Tyler	M 4
19,960	Upshur	M 2
501	Upton	E 3
11,233	Uvalde	H 5
8,613	Valverde	F 5
25,651	Van Zandt	L 2
14,990	Victoria	K 6
16,061	Walker	L 4
12,138	Waller	K 5
2,389	Ward	D 3
25,561	Washington	K 4
22,503	Webb	H 7
21,123	Wharton	K 5
5,258	Wheeler	D 1
16,094	Wichita	I 1
12,000	Wilbarger	H 1
....	Willacy (Pop. incl. in Cameron Co.)	C 6
42,228	Williamson	J 4
17,066	Wilson	I 5
442	Winkler	E 3
26,450	Wise	J 1
23,417	Wood	L 2
602	Yoakum	E 1
13,657	Young	I 1
3,809	Zapata	A 6
1,889	Zavalla	H 6

Incorporated Cities, Towns, Villages, Etc.

14,238	Abilene	H 2
2,136	Alice	I 7
672	Alto	L 3
1,155	Alvarado	K 2
1,453	Alvin, Brazoria	L 5
19,124	Amarillo	C 7
1,842	Anson	H 2
1,197	Aransas Pass	K 7
825	Archer City	I 1
1,794	Arlington	K 2
2,261	Athens	L 2
1,604	Atlanta	M 1
34,814	Austin	J 4
1,710	Baird	H 2
3,536	Ballinger	G 3
512	Bangs, Brown	I 3
1,857	Bartlett	J 4
1,707	Bastrop	J 5
3,156	Bay City	K 5
27,711	Beaumont	M 5
3,269	Beeville	J 6
181	Belcherville	J 1
699	Bellevue	K 5
496	Bells	K 1
4,164	Belton	J 3
4,102	Big Spring	F 2
903	Blooming Grove	K 3
871	Blossom	L 1
886	Boerne	I 5
4,844	Bonham	K 1
2,874	Bowie	J 1
2,669	Brady	H 3
401	Brandon	J 3
4,718	Brenham	K 5
2,000	Bridgeport	J 1
635	Bronte	G 3
13,163	Brownsville	D 7
6,967	Brownwood	H 3
4,132	Bryan	K 4
981	Burnet	I 4
1,476	Caldwell	K 4
2,579	Calvert	K 4
3,263	Cameron	J 4
1,648	Canadian	D 1
1,400	Canyon	B 2
479	Carbon	I 2
821	Celeste	K 1
724	Celina, Collin	K 1
503	Cement, Dallas	K 2
1,684	Center	M 3
3,818	Childress	D 8
1,207	Chillicothe	H 1
2,410	Cisco	I 2
1,946	Clarendon	C 2
2,065	Clarksville	M 1
692	Claude	C 2
12,259	Cleburne	J 2
1,137	Clifton	J 3
100	Clinton, Hunt	K 2
495	Clyde	H 2
3,046	Coleman	H 3
791	Collinsville	J 1
1,840	Colorado	G 2
2,756	Comanche	I 3
2,818	Commerce	L 1
1,374	Conroe	L 4
505	Coolidge, Limestone	K 3
1,513	Cooper	L 1
10,432	Corpus Christi	J 7
10,022	Corsicana	K 2
1,880	Cotulla	H 6
516	Crawford	J 3
3,947	Crockett	L 3
1,341	Crowell	H 1
3,109	Cuero	J 6
2,580	Dalhart	B 1
124,527	Dallas	K 2
803	Dawson	K 3
1,651	Decatur	J 1
1,015	De Leon	I 3
14,779	Denison	K 1
4,732	Denton	K 2
1,042	Devine	H 5
289	Dodd City	L 1
2,551	Dublin	I 3
1,717	Eagle Lake	K 5
3,536	Eagle Pass	G 6
855	Eastland	I 2
404	Ector	K 1
1,778	El Campo	K 5
640	Electra	I 1
1,707	Elgin	J 4
63,705	El Paso	A 3
326	Enloe, Delta	L 1
5,669	Ennis	K 2
1,848	Farmersville	K 2
274	Fayetteville	K 5
1,233	Ferris	K 2
886	Flatonia	K 5
1,398	Floresville	I 6
664	Floydada	F 1
1,114	Forney	K 2
104,562	Fort Worth	J 2
332	Frisco, Collin	K 2
702	Frost	K 3
7,624	Gainsville	J 1
41,863	Galveston	M 5
558	Ganado	K 5
804	Garland	K 2
627	Garrison	M 3
1,929	Gatesville	J 3
3,096	Georgetown	J 4
1,484	Gilmer	M 2
1,129	Goldthwaite	I 3
3,139	Gonzales	J 5
609	Gordan	I 2
963	Gorman	I 2
1,569	Graham	I 2
1,336	Granbury	J 2
1,065	Grand Saline	L 2
1,018	Grandview	J 2
1,708	Granger	J 4
681	Grapevine	J 2
10,099	Greenville	L 2
1,454	Groesbeck	K 3
1,379	Halletsville	K 5
1,548	Hamilton	J 3
1,978	Hamlin	G 2
2,436	Haskell	H 1
2,352	Hearne	K 4
2,104	Henrietta	I 1
1,750	Hereford	B 2
1,437	Hico	I 3
769	Higgins	D 1
6,115	Hillsboro	J 3
778	Holland	J 4
2,300	Honey Grove	K 1
112,307	Houston	L 5
6,984	Houston Heights, Harris	L 5
581	Howe	K 1
1,843	Hubbard	K 3
2,072	Huntsville	L 4
603	Iowapark	I 1
1,149	Italy	K 3
1,356	Itasca	J 3
1,480	Jacksboro	I 2
2,875	Jacksonville	L 3
314	Jayton	G 1
2,515	Jefferson	M 2
586	Jewett	K 3
1,959	Kaufman	K 2
1,147	Kenedy	I 6
945	Kerens	K 3
1,843	Kerrville	H 5
1,265	Killeen	J 4
764	Kosse	K 3
742	Kyle	J 5
1,293	Ladonia	K 1
1,850	La Grange	J 5
2,119	Lampasas	I 4
1,115	Lancaster	K 2
678	Laporte	M 5
15,749	Laredo	H 7
990	Leonard	K 1
980	Liberty	M 5
658	Lindale	L 2
1,687	Llano	C 7

TEXAS
SCALE
Statute Miles, 68 = 1 Inch.
Rand McNally's New 11 x 14 Map of Texas.
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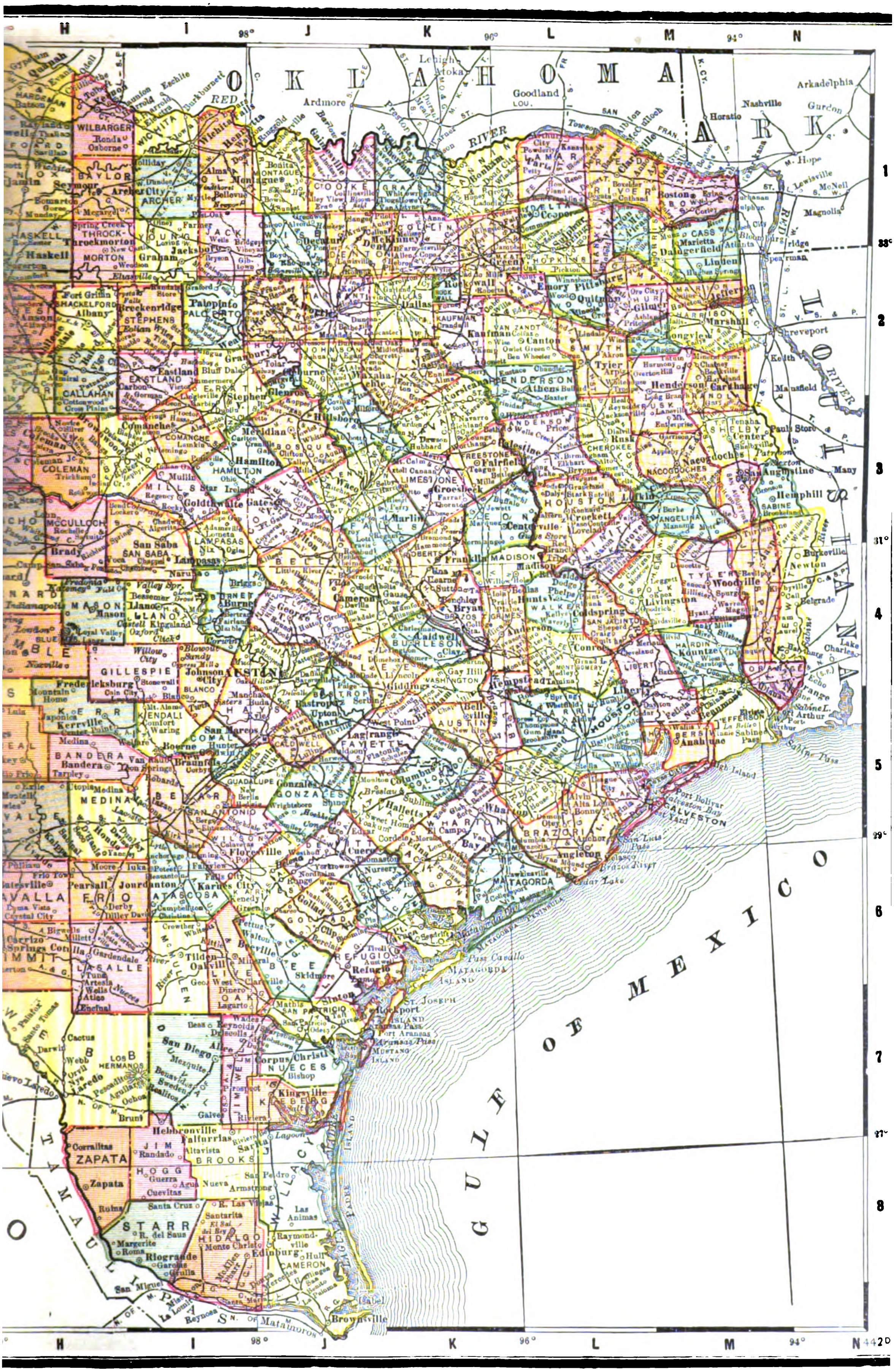
The PANHANDLE of TEXAS, on Same Scale.
NEW MEXICO
CHIHUAHUA
COAHUILA
OKLAHOMA
STAKED PLAIN
LLANO ESTACADO
RIO GRANDE
EL PASO
HUDSPETH
CULBERSON
REEVES
JEFF DAVIS
PRESIDIO
BREWSTER
PECOS
TERRELL
CROCKETT
VAL VERDE
LOVING
WINKLER
WARD
CRANE
UPTON
REAGAN
ECTOR
MIDLAND
ANDREWS
MARTIN
HOWARD
GLASS COCK
STERLING
GAINES
DAWSON
BORDEN
SCURRY
MITCHELL
YOAKUM
TERRY
LYNN
GARZA
KENT
COCHRAN
HOCKLEY
LUBBOCK
CROSBY
DICKENS
BAILEY
LAMB
HALE
FLOYD
MOTLEY
SWISHER
SCHLEICHER
SUTTON
KINNEY
DALLAM
SHERMAN
HANSFORD
OCHILTREE
LIPSCOMB
HARTLEY
MOORE
HUTCHINSON
ROBERTS
HEMPHILL
OLDHAM
POTTER
CARSON
GRAY
WHEELER
DEAF SMITH
RANDALL
ARMSTRONG
DONLEY
COLLINGS
PARMER
CASTRO
SWISHER
BRISCOE
HALL
CHILDRESS



H I 98° J K 96° L M 94° N
OKLAHOMA
ARK
LOUISIANA
GULF OF MEXICO
TAMAULIPAS
RED RIVER
Ardmore
Goodland
Arkadelphia
Nashville
Shreveport
Mansfield
Dallas
Austin
Houston
Galveston
San Antonio
Corpus Christi
Brownsville
Laredo
Waco
Matamoros
1 2 3 4 5 6 7 8
33° 31° 29° 27°
H I 98° J K 96° L M 94° N

2,945	Lockhart	J 5
750	Lockney	F 1
756	Lone Oak	L 2
5,155	Longview	M 2
633	Loraine	G 2
1,021	Lott	J 3
1,938	Lubbock	F 1
2,749	Lufkin	M 3
1,404	Luling	J 5
1,194	Lyra, Palo Pinto	I 2
1,864	McGregor	J 3
4,714	McKinney	K 1
633	McLean	C 1
627	Mansfield	J 2
1,061	Marble Falls	I 4
3,878	Marlin	K 3
13,712	Marshall	M 2
2,939	Mart, McLennan	J 3
1,936	Memphis	C 2
1,209	Mercedes	C 7
718	Meridian	J 3
2,008	Merkel	H 2
687	Mesquite, Dallas	K 2
2,694	Mexia	K 3
2,192	Midland	E 3
868	Midlothian	K 2
1,302	Miles	G 3
766	Milford	J 3
1,706	Mineola	L 2
3,950	Mineral Wells	I 2
284	Montague	J 1
983	Moody	J 3
831	Morgan	J 3
575	Mount Calm	K 3
3,137	Mount Pleasant	M 1
956	Munday, Knox	H 1
3,369	Nacogdoches	M 3
1,178	Naples	M 1
3,284	Navasota	L 4
510	Nevada	K
3,165	New Braunfels	I 5
1,338	Nocona	J 1
906	Oakwood	L 3
1,095	Olney	I 1
5,527	Orange	N 4
1,350	Paducah	G 1
1,389	Palacios	K 6
11,854	Palestine	L 3
605	Palmer	K 2
521	Panhandle	C 2
12,469	Paris	L 1
1,799	Pearsall	H 6
1,856	Pecos	D 3
467	Peniel, Hunt	K 2
517	Petrolia, Clay	I 1
1,371	Pilotpoint	K 1
1,916	Pittsburg	L 2
2,829	Plainview	F 1
1,258	Plano	K 2
7,663	Port Arthur	N 5
1,699	Port Lavaca	K 6
313	Pottsboro	K 1
3,127	Quanah	H 1
388	Queen City	N 1
537	Quinlan, Hunt	K 2
280	Ravenna, Fannin	K 1
773	Refugio	J 6
1,371	Richmond	L 5
640	Rising Star	I 2
2,073	Rockdale	J 4
1,382	Rockport	K 7
1,136	Rockwall	K 2
1,275	Rogers	J 4
941	Roscoe	G 2
1,472	Rosebud	K 3
1,198	Rosenberg	L 5
1,126	Rotan	G 2
136	Round Top, Fayette	K 5
1,210	Royse City	K 2
891	Rule	H 1
1,558	Rusk	L 3
1,640	Sabinal	H 5
400	Sabine Pass	M 5
10,321	San Angelo	G 3
123,831	San Antonio	I 5
1,204	San Augustine	N 3
834	San Elizario	B 3
206	San Felipe, Austin	K 5
4,071	San Marcos	I 5
453	Sansom, Uvalde	H 5
1,478	Santa Anna	H 3
328	Savoy	K 1
1,091	Schulenburg	K 5
3,116	Seguin	J 5
2,029	Seymour	H 1
13,667	Sherman	K 1
1,096	Shiner	J 5
3,167	Smithville	J 5
2,514	Snyder	G 2
1,147	Socorro, El Paso	B 3
3,902	Stamford	H 2
822	St. Jo	J 1
2,561	Stephenville	I 3
520	Stratford	B 1
5,151	Sulphur Springs	L 1
4,176	Sweetwater	G 2
5,314	Taylor	J 4
3,288	Teague	K 3
425	Tehuacana, Limestone	K 3
13,504	Temple	J 4
491	Tenaha	M 3
7,050	Terrell	K 2
12,640	Texarkana	N 1
678	Thornton	K 3
1,528	Timpson	M 3
797	Tioga	K 1
455	Tolar	J 2
288	Tom Bean, Grayson	K 1
1,052	Toyah	D 3
550	Trenton	K 1
1,126	Troup	L 2
1,216	Tulia	C 3
11,865	Tyler	L 2
3,998	Uvalde	H 6
708	Valley Mills	J 3
1,441	Van Alstyne	K 1
495	Venus	K 2
3,195	Vernon	H 1
3,673	Victoria	J 6
33,385	Waco	J 3
1,340	Walnut Springs	J 3
476	Waterman	M 3
6,205	Waxahachie	K 2
5,074	Weatherford	J 2
906	Weimar	K 4
779	Weinert, Haskell	H 1
576	Wellington	D 2
1,645	West, McLennan	J 3
1,505	Wharton	K 5
1,219	Whitesboro	K 1
1,563	Whitewright	K 1
766	Whitney	J 3
12,124	Wichita Falls	I 1
1,398	Wills Point	L 2
1,741	Winnsboro	L 2
1,347	Winters	G 3
1,402	Wolfe City	L 1
899	Wortham	K 3
620	Wylie	K 2
4,657	Yoakum	J 5
1,180	Yorktown	J 6

The ordinary Gulf fauna abounds off the coast where, as a consequence, very fine fishing is to be had. Tarantulas, centipedes and large red ants are the most commonly noticed invertebrates.

Agriculture and Stock Raising.—Although occupying a decreasing percentage of the population, as times goes on these industries still occupy 60 per cent of the male workers. About a sixth (28,000,000 acres) of the State is planted to crops each year, the remaining five-sixths mainly furnishing pasturage for stock. The number of farms, nearly 450,000 in 1916, has nearly doubled and the improved acreage has increased 50 per cent since 1890. The Black Prairie of the Upper Crétaceous is the most densely populated farming region, but the Permian Red Beds, and the Eocene and Neocene areas furnish large bodies of immensely fertile soil. Perhaps two-thirds of Texas is easily tillable. The use of fertilizers is still uncommon. Variations in rainfall and frost dates produce wide variations in the crop productions per acre. Very large crops and large sized fruits and vegetables are common. The average value of the crops is about $20 per acre. Intensive agriculture is beginning; the crops of the thousands of contestants for the annual prizes of the Texas Industrial Congress average about three times the State average.

The total value of farm property, $962,000,000 in 1900, $2,219,000,000 in 1910, has nearly trebled since 1900 and has quintupled since 1890. The total wealth of Texas was $6,860,000,000 in 1912, $2,836,000,000 in 1904, $2,106,000,000 in 1890. On the average, out of a thousand farmers, 425 are white owners, 408 are white tenants, 51 are negro owners and 116 are negro tenants.

The chief crop is cotton, about equal in value to all the other crops combined and raised over three-fourths of Texas. In 1912 the maximum crop so far, 4,880,000 bales, was produced. The value of the annual cotton crop ranges between 200 and 350 millions of dollars, Texas producing about a sixth of the world's crop. The corn crop averages, 100,000,000 bushels with wide variations. Wheat and oats vary much in amounts planted and in yields per acre — for wheat 12.8 bushels per acre and a 15,000,000 bushel crop and for oats 29.1 bushels per acre and a 40,000,000 bushel crop are averages. Nearly 10,000,000 bushels of rice are grown annually on 300,000 irrigated acres. The annual value of the Kafir corn, milo maize, sorghum and other forage crops is not far from $25,000,000. The production of sugar has declined to a few thousand tons. The fruit and vegetable crop exceeds $40,000,000 in value. Peaches, sweet potatoes, watermelons, tomatoes, onions, cabbages are raised in large amounts and Texas is by far the leading State in native pecans. Most of the other standard fruits and vegetables are raised in lesser amounts and there is the beginning of a citrus fruit industry along the coast. In 1917 the production of cotton was 3,125,000 bales which, excluding the seed, were valued at $375,000,000. The production in 1917 of the other principal crops in thousands of bushels and thousands of dollars was corn, 77,825, of value $129,968; wheat, 16,200, value $34,020; oats, 37,050, value $30,381; potatoes, 9,312, value $13,869; hypothetical value of all crops (United States Department of Agriculture) $684,856; average for five years, $421,277, over 20 per cent greater than any other State. The 1917 wool clip amounted to 10,045,000 pounds.

First in cotton and pecans Texas is also first among the States in cattle, sheep and goats. The United States estimates for 1918 are 1,128,000 dairy cows valued at $64,038,000; 4,660,000 other cattle at $179,667,000; 1,212,000 horses at $93,324,000; 808,000 mules at $86,456,000; 2,188,000 sheep at $16,410,000 and 3,068,000 swine at $43,259,000. Sheep and goat raising is largely confined to southwest Texas. Since 1890 the population of Texas has doubled, the number of mules and goats has more than trebled, the number of horses, swine and milch cows has remained nearly stationary, the number of sheep has decreased 50 per cent and the number of "other" cattle has decreased nearly as much.

Irrigation.— Plants fall into two fairly well-marked divisions — (a) numerous small plants widely scattered but chiefly in the west, which use the water from rivers, springs and waterholes to raise a wide variety of crops and (b) large plants, chiefly along the lower parts of the rivers, which irrigate thousands of acres under one management and sell water to individual farmers. In the southeast these large plants are almost exclusively rice producing; along the Rio Grande they raise everything but rice. The Elephant Butte Dam on the Rio Grande in New Mexico above El Paso is the only United States reclamation project directly affecting Texas where it will irrigate about 100,000 acres. Perhaps 5,000,000 acres in Texas are irrigable. About a million acres are under ditch and 600,000 acres irrigated annually, half in rice. Most of the water is pumped to the fields, the total capacity of the pumps being over 6,000,000 gallons per minute. Rice irrigation on a large scale is scarcely 15 years old and the acreage irrigated for other crops has quintupled since 1900. Farms irrigating for rice numbered 73 in 1900 and 1,088 in 1910; farms irrigating for other crops numbered 1,252 in 1900 and 4,150 in 1910. In arid Texas small irrigating plants have existed for centuries. Irrigation development has been particularly rapid since 1910 in the lower Rio Grande Valley but has not been without its backsets. The recently finished Medina Dam near San Antonio renders 60,000 acres irrigable. Between Hereford and Lubbock lies an area where irrigation water may be obtained from shallow wells. Similar but small areas exist elsewhere. There is an Artesian Belt in South Texas and various wells are sources of water for domestic uses.

Overflow lands amounting to 3,000,000 acres and swamp lands amounting to 5,000,000 acres exist. Drainage districts covering 2,000,000 acres have already been organized and 150 miles of levees have been built under a recent law authorizing community action in such matters.

Mining.— This industry is making great progress. The production of petroleum, which practically began at Corsicana in 1895, owing to the discovery of the rich Spindle Top field in 1901 and of other great fields in the succeeding years, has increased immensely but has been subject to considerable fluctuations. In the last two years the production of the older coastal and north Texas oil fields has increased and immense quantities of oil have been found in the central carboniferous region. Production leaped from 27,644,605 barrels in 1916 to 60,000,000 barrels in 1919. Oil and gas prospecting has been going on vigorously, stimulated by frequent successes. The production of most of the other minerals has had a slow but fairly uniform growth. In 1914 the total mineral production was $30,363,426, including 20,068,184 barrels of petroleum at $14,942,848; 2,247,773 tons of coal and lignite at $3,922,459; 12,433,-639 M. cubic feet natural gas at $2,469,770; 2,100,341 barrels of cement at $1,947,016. Clay products, lime, gypsum, cinnabar, salt, sulphur and various other minerals amount to the remaining $7,081,333.

Manufacturing.— Since 1900 the «value added by manufacturing» to the Texas raw products has nearly trebled. In proportion to population, in 1900 Texas manufactured a sixth, in 1915 a fourth, as much as the United States as a whole. Manufacturing has arisen chiefly in response to demands made by the immense raw products but has been retarded by scarcity of fuel and skilled labor. The major manufacturing industries are naturally based upon the major raw products. The large cotton crop supports nearly 4,000 gins (some very large) and 200 cotton-seed oil mills but only 20 cotton spinning establishments. Flour, grist and rice mills handle the entire crop of cereals but canning and preserving are far behind the opportunities offered by the large fruit and vegetable crops. There are a few large meat packeries slaughtering close to 1,500,000 animals a year. A few large petroleum refineries with a total capacity of 250,000 barrels per day are handling also much Oklahoma and Louisiana oil transported by pipe lines. The lumber area in the east, chiefly southeast, of over 50,000 square miles, upon which there is an estimated stand of 40,000,000,000 board feet of yellow pine and 20,000,000,000 hardwoods, supports about 400 sawmills and 400 other woodworking plants. About 2,000,000,000 feet of the yellow pine is being cut annually but the hardwood cut is scarcely 5 per cent of this amount. The major industries just listed include about two-thirds of the total manufacturing which, in general, is of a kind that involves only simple processes which may be done by machinery.

The manufacture of bricks and other clay products is widely and numerously scattered. Much ice is made in every town. No distilled spirits are made and no wool or mohair is woven. Dallas is second only to Nashville as a Southern publication centre. Dallas and Houston are somewhat ahead of Fort Worth and San Antonio as manufacturing places. The important manufactures of Dallas are cotton gin machinery, meat packing, flour and grist milling, cotton-seed oil and cake, leather and printing. In Houston, cotton seed, meat packing, rice cleaning, railway car repairing and brewing are the chief industries. Fort Worth leads in meat packing and flour milling, San Antonio led in brewing. In these four largest cities a third of the total manufacturing is done. Of the wage earners, 6 per cent are women, 2 per cent are children under 16 years.

The 1914 United States census statistics for Texas manufacturing are as follows:

Number of establishments	5,084
Persons engaged in manufacture	91,114
Primary horse power	335,791
Capital	283,544,000
Salaries and wages	59,179,000
Value of finished products	361,279,000
Value added to raw product by manufacture	108,135,000

Statistics for those industries where the value added by manufacture was in excess of $1,000,000 are as follows:

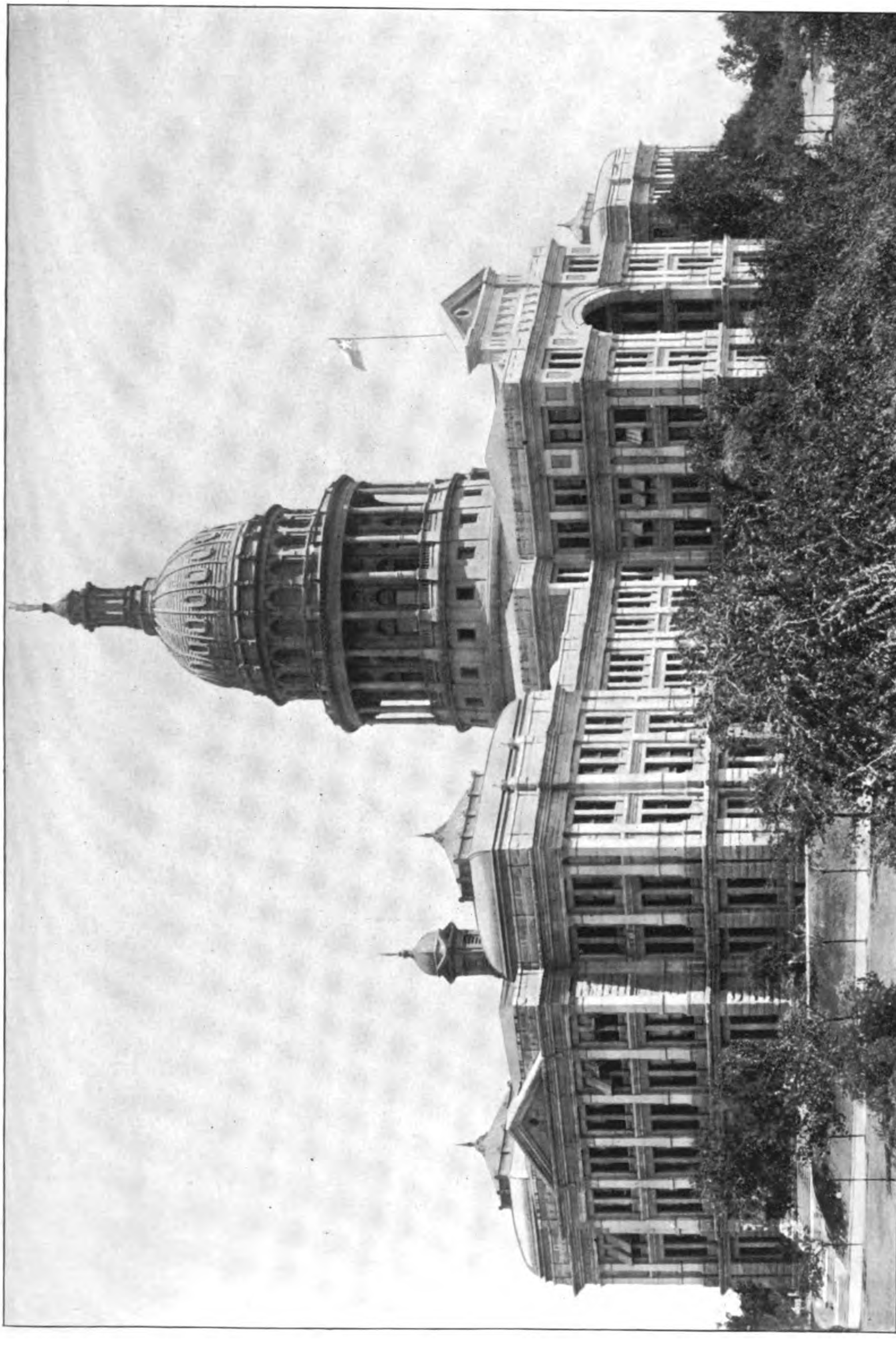
INDUSTRY	Number of establishments	Number of wage earners	Value added by manufacture
Lumber products	587	19,956	$17,101,000
Printing and publishing	1,188	4,690	11,054,000
Car repairing steam railroads	63	10,915	9,298,000
Slaughtering and meat packing	21	3,491	8,533,000
Oil, cotton-seed and cake	233	4,471	5,768,000
Liquors, malt	13	958	5,542,000
Flour and grist mill products	191	1,300	5,537,000
Foundry and machine shop products	174	3,026	4,743,000
Ice manufactured	255	1,926	3,668,000
Bread and other bakery products	530	1,949	3,361,000
Brick and other clay products	81	1,811	1,444,000

Cement, confectionery, sheet metal, cotton goods, artificial gas, leather and mineral waters are the other chief manufactures; the value added by manufacture in each case is slightly in excess of $1,000,000.

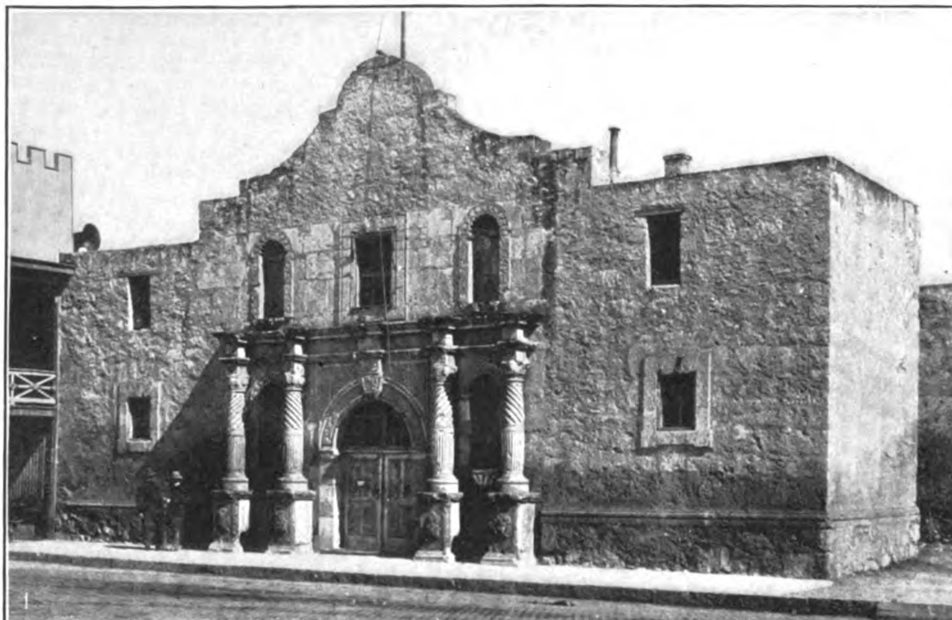
Transportation.— Before the Civil War less than 500 miles of railway were built. In 1919 there were over 15,800 miles in operation, not including 4,200 miles of side tracks. Railway building was greatly promoted by land grants until the public lands were exhausted in 1882. The leading systems are the Southern Pacific (mileage, 3,000), the Gould System, including the International and Great Northern and the Texas and Pacific (mileage, 3,000), the Santa Fé (mileage, 2,000) and the Missouri, Kansas and Texas (mileage, 1,500). The Texas Railroad Commission has authority to fix rates and otherwise to control intrastate railway traffic. The issuance of railway stocks and bonds is strictly controlled. Texas is first among the States in railway mileage, having half again as much per inhabitant and two-thirds as much per square mile as the United States as a whole. Numerous steamship lines connect Galveston with the great ports of the world. Some 500 miles of interurban and 700 miles of urban electric lines are in operation. From $10,000,000 to $15,000,000 are being spent each year upon the roads.

Commerce.— Cotton lint is the principal export, exceeding in value all the other exports combined. Most of this cotton goes to Europe via Houston and Galveston. In descending order the other chief exports are petroleum, cotton-seed products, cattle, lumber, horses, mules, rice, wool and mohair. The imports are chiefly machinery, clothing, vehicles, furniture and a wide variety of other manufactured goods. Pork, sugar, potatoes and a host of other foodstuffs are imported in considerable amounts. Strong efforts are being made to reduce such food importations by raising an increasing amount of crops other than cotton.
reduce such food importations by raising an
consumption about balance, cotton lint being

TEXAS



State Capitol at Austin



1 The Alamo, San Antonio, built in 1718   2 The Mission San José, near San Antonio, built in 1718

omitted from the count. This lint produces a balance of trade in favor of Texas of over $200,000,000 a year. Galveston is one of the 15 principal ports of the world; her imports and exports are mostly but not exclusively of Texas destination and origin.

Banks and Banking.— Law and public opinion opposing governmental banks, private banks, some of which are still flourishing, prevailed until 1865 when the first national bank was chartered at Galveston. In 1918 there were 511 national banks, with one of the 12 regional reserve banks at Dallas. The total capitalization of these banks is above $35,000,000; the total surplus is above $20,000,000; the total deposits are over $200,000,000. A State banking law went into effect in 1905 under which nearly 900 State banks have gone into successful operation. Their total capitalization is over $23,000,000, their surplus is over $12,000,000, their deposits are about $165,000,000. Depositors are protected either by a bonding system or by a State guaranty fund maintained by assessments on the banks collectively. Ten national banks have deposits in excess of $4,000,000 each; 10 State banks have deposits of over $1,000,000 each. There is no overwhelmingly preponderant bank. Interest rates are still rather high, kept up by rapidly rising land values, by large business profits and by other causes.

Government.— The present constitution was adopted in 1876 and has not been extensively amended since. The chief elective officials are the governor, attorney-general, treasurer, commissioner of the general land office, superintendent of public instruction and commissioner of agriculture, together with three railroad commissioners. The chief officials appointed by the governor are the secretary of state, adjutant-general, three penitentiary commissioners and 14 other officers whose duties relate to insurance and banking, taxes, revenues, public health, State purchasing, game, public buildings, labor, mines, pure foods, reclamation of lands, pensions, fires and masonry inspection. The judiciary is elective. In ascending order there are Justice and Municipal Courts, County Courts, District Courts, each with one judge or presiding official. Above these are nine Courts of Civil Appeals above which are the Court of Criminal Appeals and the Supreme Court. Each of these higher courts has three judges elected in rotation every two years for six-year terms. The legislature meets biennially and consists of a senate of 31 members elected alternately every two years for four-year terms and a house of 142 members elected for two-year terms. There have been numerous called sessions. The State is divided into four United States judicial districts and into 16 Congressional. Of the 18 congressmen two are, therefore, elected at large. Voting is restricted to males over 21 who have paid the poll tax and have lived one year in the State and the last six months in the district or county where the voting is to be done. The old convention system of selecting officials has been largely replaced by the general primary. The salaries of the State officials are not large. The governor has somewhat more power than is usual in the other States and he controls a considerable amount of patronage. He appoints nearly 40 State boards and a two-thirds vote of both house and senate is required to overcome his veto. In general the county is the local unit of government. Spanish influence has caused some civil law to be incorporated into the common law. Law and equity are not differentiated, common-law forms of pleading have been abolished, and a Penal Code and a Code of Criminal Procedure dates from 1856. Texas has been the pioneer in adopting the community property system, in exempting the homestead from liens, in the commission form of city government, in the regulation of railway stocks and bonds, in the regulation of farm tenant rents.

State Finances.— In 1915 the total assessed valuation was $2,755,171,793, upon which was levied a total State ad valorem tax of 55 cents on the $100. This tax, together with charter fees, poll and occupation taxes, etc., produced a total revenue from taxation of about $13,240,000. To this should be added an income of $2,140,170 arising from the State Permanent School Fund of nearly $68,000,000. The university and the Agricultural and Mechanical College possess endowments derived, like the Permanent School Fund, from the sale of State lands set apart for the schools in early days, which yielded an income of about $260,000. Expenditures were as follows: State departments, $1,633,505; judiciary, $1,057,197; eleemosynary institutions, $2,861,876; Confederate pensions and homes, $1,558,171; miscellaneous, $262,821; higher education, $1,754,077; public schools, $7,999,059. Income and expenditures are increasing at least 5 per cent a year. Of the ad valorem tax of 55 cents, five cents is specifically set aside for Confederate pensions, 20 cents for the public schools. The State debt is negligible, but the total debt of the counties exceeds $30,000,000; of the cities it is about $60,000,000. County tax rates are generally under $1 on $100 but in some cases the city rates reach $2.

Education.— To the $7,999,059 spent by the State on the public schools in 1915 should be added $6,387,866 raised by local taxation in counties, districts and cities and $518,628 derived as income from Permanent County School Funds, similar to the State Permanent Fund, and amounting to nearly $13,000,000. On about 1,100,000 children of free school age Texas spent in 1915 about $14 per child. There are nearly 25,000 teachers, of whom scarcely 1,500 hold college degrees, of whom about 3,000 hold certificates that would admit to standard colleges. The rural schools are open scarcely six months per year. There is such pressing need of improving rural education that the legislature of 1915 appropriated $1,000,000 for the purpose and it is probable that this amount will be increased in future. A compulsory law now going into effect will cause a much needed improvement in attendance. The high schools, between 500 and 750 in number, are of very unequal merit but are improving fairly rapidly. The training and the salaries of teachers are increasing. The value of the public school buildings exceeds $30,000,000. Receipts from sales of school building bonds were $2,847,891 in 1915; the amount collected by local taxation for redemption and interest on bonds was $1,719,682. There are numerous private secondary schools. The native white illiteracy was 6.1 per cent in 1900, 4.3 per cent in 1910; of negro illiteracy 24.6 per cent in 1910, 38.6 per cent in 1900.

There are State normals at Huntsville, Denton, San Marcos, Canyon City, Commerce and Alpine for whites and at Prairie View for negroes. The Girls' Industrial College is at Denton, the Agricultural and Mechanical College (which has income from the United States and from other sources not enumerated above) for boys is at Bryan, the University of Texas is at Austin with the exception of the medical department which is at Galveston and a school of mines at El Paso. These State higher schools, whose total enrolment, regular session, exceeds 8,000, are almost wholly supported by biennial legislative appropriations. There are nearly 50 private and denominational colleges of various grades, with an attendance in excess of 14,000. Chief among these are the new Southern Methodist University at Dallas and the Rice Institute (endowment over $10,000,000) at Houston, together with the much older Baylor University (Baptist) at Waco, Southwestern University (Methodist) at Georgetown, Austin College (Presbyterian, for boys) at Sherman, Trinity (Presbyterian) at Waxahachie and Texas Christian University at Fort Worth.

Charities and Corrections.— Three insane asylums, with a total of 4,000 inmates, are located at Terrell, Austin and San Antonio. There is an epileptic colony at Abilene; a blind institute, a deaf, dumb and blind institute for negroes, a deaf and dumb institute, a Confederate home, a woman's Confederate home and a farm colony for feeble-minded are at Austin; an orphan's home is at Corsicana; a juvenile training school for boys is at Gatesville and for girls at Gainesville; a tuberculosis sanitarium is at Carlsbad. In addition to these State-maintained institutions there are numerous denominational and private hospitals and retreats of very various kinds. The State penitentiaries, containing usually from 4,000 to 5,000 inmates, are at Rusk and at Huntsville, and, mainly through farming, are designed to be self-supporting, but have in recent years created large deficits.

Religion.—Accurate recent statistics do not exist. The best approximations are as follows: Baptists, 490,000; Catholics, 375,000; Methodists, 375,000; Presbyterians, 85,000; Disciples of Christ, 60,000; Lutherans, 35,000; Protestant Episcopals, 20,000; Jewish, 15,000; all other denominations, 45,000. Most of the negroes are either Baptists or Methodists. Other approximate church statistics are as follows: Churches, 9,500; church organizations, 12,500; Sunday-school teachers, 65,000; Sunday-school pupils, 600,000; value of church property, $27,000,000; seating capacity of the churches, 3,000,000; church debts, $1,350,000. The Y. M. C. A. and Y. W. C. A. hold property worth $1,700,000.

Population.— The first United States census taken was that of 1850 when the population was 212,592. In 1870 the population was 818,579; in 1890 it was 2,235,523; in 1910 it was 3,896,542. The present rate of increase is about 85,000 a year. Native white Americans form 73 per cent of the population, 51 of this 73 being native white Texans. Foreign born Europeans number 3 per cent, Mexicans 7 per cent, negroes 17.7 per cent (20.4 per cent in 1900). A large German element in the population of South Texas dates from 1848. In general Texas is Southern with a strong flavor of the West. The occupation percentages for the male workers (who number about 1,330,000 in 1915) are: Agriculture and stock raising, 60 per cent; manufacturing and mining, 14 per cent; trade and transportation, 15 per cent; professions, 3 per cent; all other occupations, 8 per cent. White farm tenantry and the percentage of women at work are increasing. The towns are increasing much faster than the country, 68 per cent as compared with 19 per cent during the last census decade. The five largest cities increased 107 per cent. Only 19 per cent of the people live in towns of more than 10,000 population. Sixty-six per cent of the population is rural. According to the estimates of the United States census for 1916, Dallas, San Antonio, Houston and Fort Worth have passed 100,000. El Paso is near 50,000 and Galveston 40,000; Austin, Waco and Beaumont have passed or are nearing 30,000. Between 20,000 and 10,000 in approximately descending order are Laredo, Denison, Sherman, Amarillo, Marshall, Abilene, Temple, Brownsville, San Angelo, Paris, Texarkana, Cleburne, Palestine, Tyler, Wichita Falls, Corsicana, Corpus Christi and Greenville.

History.— The first explorers were Spaniards, Cabeza de Vaca, 1528–36, and Francisco Vasquez de Coronado, 1540–42. Other Spanish gold hunters traversed the State occasionally during the next 140 years but it was not till 1682 that a still-existing Indian pueblo under Spanish auspices was found at Ysleta near modern El Paso, 200 years younger. La Salle, driven west by a storm while searching for the mouth of the Mississippi down which he had sailed three years previously, built in 1685 near Matagorda Bay a fort which was soon destroyed by the Indians. Four Frenchmen found refuge among the more peaceable Tejas Indians who, as a result, have their tribal name perpetuated as «Texas.» Alarmed by this accidental and unsuccessful French invasion, the Spaniards of Mexico established in 1690 the Mission San Francisco de los Tejas, near modern Nacogdoches, but this far-away mission was soon abandoned. Later various other scattered missions and forts were established, but in 1800 those at San Antonio, Nacogdoches and Goliad were the chief results of over 200 years of Spanish colonization. San Antonio, begun in 1718, became in 1730 the first civil European settlement in Texas.

The history of modern Texas begins in 1821. The Spaniards having failed really to settle the country, three abortive invasions between 1800 and 1821 by Anglo-Americans were shadows of coming events. In 1821 Mexico finished successfully her war of independence begun with Spain in 1810; in 1821 the United States gave up a claim to Texas arising from the purchase of Louisiana from France in 1803; in 1821 Moses Austin obtained permission to locate 300 American families but, dying, his son Stephen established the first permanent Anglo-American settlement at San Felipé de Austin on the lower Brazos River in December 1821. During the next 15 years probably 30,000

Americans came to Texas, settling mainly along the rivers between San Antonio and Nacogdoches southward to the coast. They came, sometimes bringing their slaves with them, because a fertile and unoccupied land was calling to them, not because, as has sometimes been maintained without evidence, they specifically planned to extend the slave-holding area. Remote from real Mexico, they practically governed themselves and formed no close or genuine ties with their adopted country. A federal Mexican republic resulting in 1824, Texas and Coahuila became one state divided into the departments of Saltillo, Monclova and Texas. Revolution and disorder prevailing continually in Mexico, when Santa Anna established there a dictatorship in 1835, the American Texans proclaimed a provisional government and declared in favor of a union with the Mexican liberals together with a restoration of the Federal Constitution of 1824. Santa Anna sent troops into Texas and war began. The desperate defense of the Alamo at San Antonio by 183 Texans under W. B. Travis in which the defenders were killed to a man and the battle of San Jacinto in which Santa Anna was defeated and captured by a Texan army under San Houston were the outstanding events of the war. Practical independence resulted and between 1836 and 1845 Texas was an independent republic, a unique experience for one of the States of the Union. In 1845, after a long conflict over slavery, Texas was annexed to the United States, retaining all her public lands and the right to subdivide into not more than five States. Claims to a portion of New Mexico were abandoned later for $10,000,000 which were used to pay the debts that the Republic of Texas had accumulated. The annexation of Texas brought on the war between the United States and Mexico which made the Rio Grande an international boundary. After a decade of peaceful statehood Texas abandoned the Union for the Southern Confederacy, furnishing probably 100,000 soldiers. The last battle of the Civil War was fought at Palmito, near Palo Alto, on the Rio Grande, 13 May 1865. Texas was not the scene of very active military operations; Federal troops attacked the coast but could not penetrate further. A reconstruction government of the usual type prevailed until 1874 when Gov. E. J. Davis was driven from office.

Since 1874 Texas has been Democratic by large majorities. The carpet bag constitution of 1869 was replaced in 1876 by the constitution now in force. In 1874 the Texas Rangers, a famous State constabulary, was organized to protect the frontier from Indians. The debt left by the Davis administration was paid during the succeeding Coke, Hubbard and Roberts administrations. In 1884 fence cutting wars that arose because of the rapid spread of barb wire demanded special and drastic legislative action. The old Capitol burned down in 1881 and 3,000,000 of acres of Panhandle public land was paid for a new granite Capitol begun in 1885. The most important struggle since Reconstruction days was that of 1892 when Gov. J. S. Hogg fought and won a hotly-contested campaign which resulted in the establishment of a railroad commission with large powers and the passage of anti-trust laws and laws re-

stricting the alien ownership of land. Prohibition, first voted on in a State election in 1887, has since been a much-fought issue. At present all of the people live under well-enforced local option laws. In 1896 the United States Supreme Court fixed finally the boundary of Texas by awarding Greer County in the forks of the Red River to what is now Oklahoma. Texas from time to time has suffered from river floods and from tropical storms along the coast. At Galveston in 1900 thousands of lives and much property were lost in a storm. Out of this calamity grew the Galveston Sea Wall and the commission form of city government. The supremacy of the Democratic party, threatened for a few years by Populism before the Democrats adopted free silver in 1896, shows no signs of failure. The political problems now before Texas are the development of a more efficient system of public schools, the reduction of farm tenantry, compulsory investment of life insurance funds in Texas securities, abolition of the fee system of paying county officials, penitentiary reform, reforms in legal procedure and better public roads.

PRESIDENTS OF THE REPUBLIC.

David G. Burnet, ad interim	1836
Sam Houston	1836–38
Mirabeau B. Lamar	1838–41
Sam Houston	1841–44
Anson Jones	1844–46

GOVERNORS OF THE STATE.

J. Pinckney Henderson	Democrat	1846–47
George T. Wood	"	1847–49
P. Hansborough Bell	"	1849–53
James W. Henderson (acting)	"	1853
Elisha M. Pease	"	1853–57
Hardin R. Runnels	"	1857–59
Sam Houston	Independent and Unionist	1859–61
Edward Clark (acting)	Democrat	1861
Francis R. Lubbock	"	1861–63
Pendleton Murrah	"	1863–65
Interregnum		1865
Andrew J. Hamilton, Prov., appointed	Conservative	1865–66
James W. Throckmorton	"	1866–67
Elisha M. Pease	Appointed	1867–69
Interregnum		1869–70
Edmund J. Davis	Republican	1870–74
Richard Coke	Democrat	1874–77
Richard B. Hubbard	"	1877–79
Oran M. Roberts	"	1879–83
John Ireland	"	1883–87
Lawrence S. Ross	"	1887–91
James S. Hogg	"	1891–95
Charles A. Culberson	"	1895–99
Joseph D. Sayers	"	1899–1903
S. W. T. Lanham	"	1903–07
Thomas M. Campbell	"	1907–11
Oscar B. Colquitt	"	1911–15
James E. Ferguson	"	1915–17
William P. Hobby	"	1917–

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H. Y. BENEDICT,
Dean, University of Texas.

TEXAS, The University of, the head of the public school system of the State, is located at Austin, except the medical department at Galveston and a loosely connected school of mines at El Paso. The first step toward its establishment was taken in 1839 when the Congress of the republic set aside 40 acres for a campus in the future city of Austin and 50 leagues of public land as an endowment. In 1858 the legislature increased the endowment by adding $100,000 of United States bonds and lands amounting to 10 per cent of all the public lands granted to railways. The constitution of 1876 replaced this 10 per cent by 1,000,000 acres, to which the legislature added another 1,000,000 in 1883. The university was finally organized in 1881, located by a popular vote and opened to students in 1883. Before this the Agricultural and Mechanical College had been opened and although vaguely made a branch of the university by the constitution of 1876, has existed separately under its own board of directors. From its 2,000,000 acres, which are in West Texas and leased to cattlemen, the university has an income of nearly $170,000; fees and interest on $650,000 derived chiefly from land sales amount to about $50,000 more. The annual appropriation for running expenses from the legislature for 1919–20 is $950,000. The constitution prohibits the use of legislative appropriations to pay for buildings, and the act establishing the university limits the matriculation fee to $30, admits men and women on equal terms and prohibits any sectarian instruction or religious tests for officers or students. The government is in the control of a board of nine regents appointed by the governor with the consent of the senate, three every two years for terms of six years. The departments of the university are (1) the college of arts, (2) the department of law, (3) the department of engineering, (4) the department of medicine, including pharmacy and nursing, (5) the department of education, (6) the graduate department, (7) the summer school and summer normal, (8) the department of extension, (9) the bureau of economic geology and technology. The B.A., B.S., M.A., Ph.D., LL.B., LL.M., C.E., E.E., M.E., and M.D. degress are conferred. Provision is made for taking the B.A. and M.D. in seven years, the B.A. and LL.B. in six. Twenty courses, somewhat elective under a system of grouped studies, are required for the B.A. Fourteen and one-half high school units are required for admission, the department of law requiring in addition 10 college courses, the medical department also requiring 10. The LL.B. requires three years, the M.D. four years of nine months each. The summer school offers during the summer session of three months as many as possible of the courses of the regular session. In addition to the older collegiate subjects, courses in journalism, home economics, business administration, music and Slavic language are offered. The usual collegiate clubs, fraternities, associations, fellowships and scholarships abound, and an unusually broad system of student government prevails, accompanied by the honor system on examinations. The campus at Austin is surrounded by churches and an association of religious teachers give courses which are allowed to count toward the B.A. At Austin are the Main, Law and Engineering buildings, the library, two dormitories, a power-house, a chemical laboratoy and about 25 "shacks," cheap frame buildings which growth has necessitated and which are used for various purposes. At Galveston are the Medical College building, the five buildings of the John Sealy Hospital, a dormtory for women and a nurses' home. The library has over 150,000 bound volumes, including a number of rare first editions. The laboratories are well equipped. There are various funds, mostly small, and numerous special collections. During the regular session of 1918–19, 3,100 students were in attendance. In addition 500 other individuals were in the summer school, 500 in the summer normal and 700 doing correspondence work. The attendance has more than doubled since 1908. The voting faculty numbers 150, the whole staff over 350, the affiliated high schools nearly 300. Most of the Texas colleges officially use the affiliated list of the university.

TEXAS AGRICULTURAL AND MECHANICAL COLLEGE, located at College Station, Brazos County, Tex. It was established in 1871, receiving as an endowment 180,000 acres of land from the National government, in accordance with the Morrill Land Grant Act of 1862. Opened for the reception of students 4 Oct. 1876. The government of the college is vested in a board of nine directors, appointed by the governor for terms of six years. It offers 11 four-year courses leading to the degree of B.S., as follows: Agriculture, architecture, architectural engineering, chemical engineering, civil engineering, electrical engineering, general engineering, mechanical engineering, military engineering, textile engineering. A four-year course in veterinary medicine leading to the degree of D.V.M. is also offered. Two-year courses in agriculture and engineering are provided for students with limited preparation, who are over 18 years of age. Graduate work in agriculture and engineering is also provided. The college farm and grounds contain 2,500 acres, of which 750 are under cultivation; the grounds and buildings in 1916 were valued at $2,000,000; in 1915 and 1916 buildings to the value of $375,000 were erected, including a hospital, an assembly hall, a veterinary building, a stock judging pavilion and a steam plant. The library in 1916 contained 25,000 volumes; the enrolment for 1915–16 was 1,415, the faculty 103.

TEXAS BLUEGRASS. See GRASSES IN THE UNITED STATES.

TEXAS CHRISTIAN UNIVERSITY, located at Fort Worth, Tex. It was founded as a private institution in Thorp Springs, Tex., in 1875, and chartered under the name of the Add Ran College; in 1890 the college became the property of the Christian Church of Texas, and in 1895 was moved to Waco, Tex., and the name was changed to Texas Christian University. In the spring of 1910 the college was burned at Waco, and it was moved to Fort

Worth, Tex., that year, where it opened in the fall of 1910. The university now includes the following departments: (1) The Add Ran College of Arts and Sciences; (2) the College of the Bible; (3) the College of Business; (4) the College of Music; (5) the School of Oratory; (6) the School of Art; (7) the Preparatory School; (8) the department of domestic science; (9) the department of law; and (10) the College of Medicine, located at Fort Worth, Tex. The university is coeducational and is the school of the Disciples of Christ in Texas; no secret societies are permitted but the students maintain four literary societies and an athletic association besides other art and religious societies. The campus contains 50 acres on high ground above the city. The buildings include the Girls' Home (Jarvis Hall); Worth Hall, Clark Hall, Goode Hall, Brite College and the Medical College. The income is about $100,000 yearly; the library contains over 12,000 volumes and is a government depository; the students in all departments in 1915–16 numbered 710 and the faculty 78.

TEXAS FEVER, in cattle. See RINDERPEST.

TEXCOCO, täs-kō'kō. See TEZCUCO.

TEXEL, těk'sěl, Netherlands, an island, the largest in the West Friesian group, that separates Zuyder Zee from the North Sea. It is separated from North Holland by the Strait of Mars-Diep. Its area contains about 75 square miles, mostly fertile lands, which afford fine pasturage and fields for the growing of crops. Stupendous dikes protect the island. Sheep-raising is the chief industry, and the wool and cheese are noted products. Texel has an interesting war record. It was here that the celebrated victory of Admiral Blake was won over the Dutch in 1653. Another important battle was fought (1673) between united France and England against Holland. In 1797 the island was blockaded, and the Dutch fleet surrendered to Admiral Mitchell in 1799. Pop. about 6,500.

TEXIER, tĕs-yā, **Charles Félix Marie,** French traveler and archæologist: b. Versailles, France, 29 Aug. 1802; d. Paris, 1 July 1871. His works comprise 'Description de l'Asie Mineure' (1839–48) and 'Description de l'Arménie, de la Perse, et de la Mésopotamie' (1842–45).

TEXTBOOK AND ORAL TEACHING. See EDUCATION, ELEMENTARY.

TEXTILE DESIGNING. This term is used for the designing of textiles in which the pattern is obtained in the weaving and not by subsequent printing. The simplest patterns are in stripes and checks. By running 5 or 10 white threads and 5 or 10 gray threads alternately in the warp, stripes would be made. If the same thing was done also with the weft or filling, a checkered pattern would result. In arranging a pattern the designer first considers the weight of cloth desired and calculates what size of thread or «yarn» he will use, and how many threads there will be to the inch. He usually bases his design on the inch. Having an intimate knowledge of the loom harness, which determines the arrangement of the threads or «weave,» he knows its limitations and just what combinations are practicable. If he uses a plain weave, in which the threads interlace alternately, it is very easy to design checks and plaids. He may decide to use the twill, in which the shuttle carries the woof-threads over one and under two or more warp-threads. By carrying this twill principle a little farther, he may produce a diagonal cloth. If he is dealing with silk, and wants a glossy surface, he may decide on a satin weave, which reduces the number of crossings of warp and weft, permitting a close texture and a glossy finish on one side. Successful designs determine largely the stability of the cloth, for users judge a fabric mainly by the effect at first sight. The patterns must be harmonious or with artistic contrasts to please the various tastes. To sell at certain prices, they must have definite weights per yard, as buyers of large quantities will require 10, 12, 14, etc., ounces to the yard. The designing of silk, linen, wool and other fabrics involves many differences, which must be thoroughly understood. And carpet and rug designing is a different business, requiring complete knowledge of their manufacture. The designers of rugs try to imitate the higher priced hand-made rugs from the Orient, and often succeed admirably. Consult Beaumont, 'Color in Woven Design' (new ed., 1912). See WEAVING.

TEXTILE INDUSTRY. American.— In 1800 there were no textile mills, as the term is now understood, in the United States. Whatever the American people did in the way of manufacturing their own clothing was mostly done in the household; the spinning wheel and the handloom were utensils as familiar in the old-fashioned kitchens as the pots and kettles of the housewife. The homespun garments worn by our forefathers were fashioned out of wool grown on the home farm, carded by hand-cards, washed in tubs, spun and woven by hand, fulled and finished at home, cut up and sewed — all by the joint labor of husband, wife, sons and daughters. The finer clothes worn in those days were all imported; and as the colonies grew and multiplied, and their consumption of English textiles increased, the manufacturers of the mother-country foresaw a wondrous new market opening up before them. The desire to retain and increase that market for textiles, in the manufacture of which England already led the world, was far more prominent among the causes leading up to the American Revolution than its historians have yet discovered.

Colonial Homespun.— The homespun garments of colonial days were plain, and wore like iron; their ingredients were indicated in the name commonly applied to the cloth — «linsey woolsey.» It was a fabric of woolen weft, woven on a linen warp. Linen was much more commonly produced in the household than cotton fabrics, and wool was more in use than all other fibres combined. Cotton was a scarce commodity in Colonial America until long after the Revolution. It possessed a value equal to that of wool, and sometimes very much higher. What little of it was used prior to the 19th century was mostly imported from Barbados. When Samuel Slater started the first American cotton mill at Pawtucket, in 1793, he insisted upon using cotton from the Indies, because of the poor quality of the cotton then raised at home. No one dreamed, when the «Shipping and Commercial List and New York Price Current» first made its appearance, that America was destined to become the cotton-producing country of the world; nor did Slater's little mill of 250 spindles, which had then been in operation five years, give signs that it was the germ of an American industry which would consume annually within 100 years more cotton than all the world was then growing. The history of the textile industries during the colonial period is nowhere suggestive of the development which confronts and amazes the student at the opening of the 20th century, who finds them, with their subsidiary industries, employing more capital and creating a greater value of annual product than any other group, except iron and steel.

Expedients of the Colonists.— Our forefathers realized how important it was that the colonists should learn to clothe themselves. They resorted to all sorts of expedients, some of which smack strongly of state socialisms, to overcome the difficulties in the way. They offered bounties to increase the number of sheep and promote the growth of flax. In Massachusetts laws were passed making it compulsory that each family should spin a given quantity of yarn every year, under penalties of heavy fines. Gradually the household textile industries assumed an importance which alarmed the mother-country, and the Lords of Trade attempted by various restrictive orders to prevent and harass a development which threatened to destroy the colonial market for the chief products of British industry. Parliament passed an act in 1774 — which was shortly after the Arkwright inventions had inaugurated the modern factory system — forbidding the exportation, under heavy penalties, of any of the machines used in the cotton, silk, woolen or linen manufacture. This statute, which remained in force, with certain modifications, until 1845, was evidence of a puerile hope that the English people could keep the fruits of inventive genius bottled up in their little island, while England permitted her sons to carry their inventive ideas across the water.

First Woolen Factory.— Slater brought here his spinning machinery ideas; in the same way Arthur Scholfield, three years later, invented the first wool-carding machine, which he built and put into operation at Byfield, Mass., in 1794, thus fixing the date of the beginning of the factory manufacture of wool by machinery operated by power in the United States. American machinists and inventors did the rest. It is not to be denied, however, that the English statute did retard, embarrass and make trebly difficult the early development of our textile factories. A century ago the American textile industries were easily 100 years behind those of Great Britain.

Steps of Evolution.—It would be interesting to follow the evolution of the household industry, by slow and gradual steps, into the highly organized factory system of America to-day. First came the neighborhood fulling-mill utilizing the friendly services of the adjacent stream, and relieving the housewife of the labor of fulling and finishing the cloths and blankets accumulated by the busy shuttle during the long winter evenings. Then the carding-machine was added to the fulling-mill; the farmers for miles about brought their wool to be converted into rolls ready for the spinning-wheel. After Slater had successfully applied the Arkwright invention to the spinning of cotton at Pawtucket, here and there throughout New England little mills gradually appeared which spun both cotton and woolen yarns by water power. Handlooms were still used in all these mills until 1813, when the invention of a power-loom by Francis C. Lowell led to the building of the Waltham cotton factory by the Boston Manufacturing Company, and the American textile mill first took on the characteristics which have since increasingly distinguished it. Power spinning and weaving machines were rapidly applied to the manufacture of woolens, and it began to be seen that the household manufacture of textiles was disappearing before the greater economy and efficiency of the factory system. The transition was not rapid, and the ups and downs of our first textile mills were numerous and discouraging.

War of 1812.— The outbreak of the War of 1812, and the non-intercourse acts and embargo which preceded it, were the most potent factors in completing the transition. The total suspension of importations threw our people suddenly upon their own resources for their entire supply of clothing. Cotton and woolen mills were quickly built. High prices and the promise of quick fortunes drew many men with little or no knowledge of manufacturing into the business. All went well enough until the war ended; then followed collapse and ruin. The work of laying the solid foundations of textile manufacturing had all to be done over again. Imported cottons and woolens again invaded the market with a rush, and the domestic manufacturers found it impossible to compete with them either in quality or in price. Labor was unskilled and hard to get; knowledge and experience were sadly wanting; machinery was clumsy and defective; the country was poverty-stricken, and trade and the national finances thoroughly demoralized.

First Protective Tariff.— Then first began the great battle in Congress, which was waged more or less intermittently ever since, for the protection of the domestic manufactures by means of tariff laws. The Tariff Act of 1816 — the first of the series in which the principle of protection was recognized in the rates fixed as a distinct purpose of the law, conjointly with the raising of revenue — was much more favorable to the cotton than to the wool manufacture, because it applied the minimum principle to cotton cloths, which was in effect a specific duty of 6¼ cents a yard, while the simple ad valorem rate of 25 per cent was applied generally to woolen goods. From the date of that law the cotton manufacture began a healthy development, and it naturally grew much faster than the wool manufacture. The later tariffs were in like degree, as a rule, more favorable to cotton than to woolens; partly owing to this fact and partly to other causes, such as the much more delicate, complicated and expensive operations incident to the latter, the cotton manufacture has at all times except during the Civil War shown a greater prosperity and on the whole a more rapid development than its sister industry. But in both industries for many years it was an up-hill struggle against great odds. Few fortunes were made; many were lost, and the courage and tenacity of those early textile manufacturers deserve to be remembered.

From 1850.— In the last half of the 19th century there was an increase in the value of products of about six times, and not less than 10 times if it were possible to measure this product by quantity instead of by value. Even the largest figures convey an inadequate idea of the relative importance of our textile mills in the industrial economy of the nation, for these mills supply the materials for a great group of subsidiary factory industries, such as the wholesale clothing manufacture, the shirt manufacture, etc. When we aggregate these, and add to them the value of the products of the linen, jute, hemp and bagging mills of the country, we find that the product of our textile mills is larger in value than that of any single line of related industries, iron and steel excepted. The products of the textile mills and the factory products growing out of them are equal in value to more than one-ninth of all our manufactures.

Machinery and Diminished Cost.— The decrease in the cost of goods during the last half century has been one of the most striking phases of the development. This decrease is due in some measure, of course, to the decreased price of the raw materials from which they are made; but in even larger measure is it due to the remarkable advance in the methods of manufacture — to the new and more perfect machinery employed, in the invention of which American mechanical genius has contributed certainly as much as that of any other people, and perhaps more. All the fundamental inventions in spinning machinery were of English origin; so was the combing machine and the power loom. The English have a remarkable record in this respect, and the French and the Germans have also done much in the invention of labor-saving textile machinery. But the American record may be shown to surpass them all. The wool-carding machinery of all countries owes its chief improvements over the machines of a century ago to the invention of John Goulding of Worcester, Mass., whose patent, dated 1826, dispensed with the splicing-billy and produced the endless roll or sliver. Michel Alcan, the distinguished French writer, describes it as «the most important advance in the wool manufacture of the 19th century.» It was not a step,» he says, «but a flight.» The modern cotton spindle, making 10,000 revolutions a minute, is an evolution of our own mechanics. It has been shown that the saving effected by the new forms of spindle invented and adopted in the United States since 1870, when 5,000 revolutions a minute was the average speed, has been more than equal to the capacity of all the warp-spinning machinery in use in this country in that year, and to-day more than three times as much warp-yarn is spun in the United States as in 1870, a rate of increase without parallel since the earliest introduction of the cotton manufacture. The Lowell loom was the first successful application of power to the weaving of cotton, the Crompton loom to the weaving of fancy woolens and the Bigelow loom to the weaving of carpets. «Not a yard of fancy woolens,» wrote Samuel Lawrence, «had ever been woven by power looms in any country until it was done by George Crompton at the Middlesex Mills in 1840.» Every carpet ever woven was woven by hand until the power loom of Erastus Brigham Bigelow revolutionized the industry. Beyond these fundamental machines the American mechanisms for expediting processes, for automatic devices, for dispensing with intermediate help, have been so numerous that they have completely transformed the modus operandi of textile mills throughout the world. These mechanisms are more generally in use to-day in the best American textile mills than in those of any other country. So far as mechanical equipment is concerned, our best mills, whether cotton or woolen, are fairly equal to the best in any foreign country. It does not follow that textile manufacturing is done here, as a rule, with equal economy in cost.

Mills and Equipments.— In structural equipment the modern American mill is in some respects superior to the average foreign mill. It is not so massive a structure, nor so solidly built, brick being used here, while the English generally use stone; but in the lightness and airiness of its rooms, in economy of arrangement and in general completeness of equipment and care for the comfort and convenience of the operatives, it is usually superior. The lesson is fast being learned by our textile manufacturers that in these days of close competition and small profits successful manufacturing requires that buildings shall be of the latest design and the most approved management, and that machinery shall not only be modern in make, with every latest improvement, but must also be kept in perfect condition by constant renewal. Many parts of the machinery required for the equipment of our textile mills are still necessarily imported from England, because not made, or less perfectly made, in the United States. Our machine manufacturers have been advancing as rapidly in recent years as the textile mills themselves, and the time cannot now be far distant when every new mill built in America will be equipped throughout with American-made machinery. But here again the United States shows a firm grip and *exports* have reached beyond the million dollar mark. Textile machinery in 1914 was being made in 241 establishments valued at $30,437,689. In that year machinery was *exported* to the value of $1,308,048.

Variety of Fabrics.— The American textile mills now supply practically every variety of fabric made in the world, with the exception of linens and the very finest grades of other fabrics. Great sums of money have from time to time been invested by daring manufacturers in constructing plants for the manufacture of linen fabrics. The result has often been disappointment and failure. These obstacles are climatic in the first instance, flax being a fibre which requires more moisture than any other for its successful manipulation. Again, there is difficulty in obtaining a home supply of suitable raw material. Years of high protection have failed to persuade the American farmer into growing flax for fibre. The history of the linen manufacture in other countries seems to establish the fact that it is the one textile manufacture likely to remain segregated in a few localities like Holland and Ireland, where the fibre is grown on the spot, where the climate is peculiarly adapted and where the help has acquired an expertness born of generations of experience. Moreover, linen is the one textile the consumption of which has not appreciably increased with the growing perfection of textile machinery. The other fibres, less difficult to handle, more susceptible to cheap manipulation, continually encroach upon its uses.

Silk Industry.— Perhaps the most striking contrast to our experience with linen is that afforded by the silk manufacture. At first sight it would appear that this must be the particular textile industry which could not flourish in America. Since last century's whirlwind of speculative mania to cultivate the silkworm which swept New England in the thirties, and wrecked the fortunes of many too credulous farmers, we have settled down to the conviction that America cannot grow raw silk in competition with China, Japan and Italy. Moreover, the silk manufacture, like the linen, has always been highly specialized and localized. The city of Lyons, in France, had well nigh monopolized the manufacture, so far as it had escaped from the hand processes of the Eastern nations. The skill and taste of generations have been concentrated upon the production at these centres, of fabrics which in beauty of design, in richness of coloring, in delicacy of workmanship, alone among the fabrics made by modern machinery, rival the splendors of mediæval textile art. England has for centuries struggled in vain to place her silk manufacture on equal terms with it. Nevertheless we have built up in America, in the last 45 years, a silk industry which among machine-using nations is second only to that of France, and is to-day supplying our people with the bulk of the silken fabrics consumed by them. We owe this great achievement largely to the energy and the genius of the Cheney family, father and sons, of South Manchester, Conn. The Cheneys began the manufacture of spun silk nearly half a century ago. About the same time, John Ryle, sometimes called the father of the American silk industry, had become superintendent of a little silk mill in Paterson, N. J., which he afterward purchased and gradually enlarged. At first sewing silks only were made, then ribbons were added, and in 1842 Mr. Ryle built a number of looms for silk piece-goods — the first to be successfully operated in America; and the industry in all its branches has since developed so rapidly there that Paterson, which calls itself the Lyons of America, now occupies to this industry the same relation that Fall River does to the cotton manufacture and Philadelphia to the wool manufacture. During the Civil War the high duties stimulated the silk industry and diversified its product. The making of plain grosgrain dress silks was then started, and at the present time brocaded silks and satins are manufactured on a large scale; indeed there is no form of fabric into which silk enters which is not now produced in great variety. Especially noteworthy has been the recent development in the manufacture of silk plushes and all varieties of upholstery goods. The value of home-made silk goods was in 1880 just about equal to the foreign value of the goods imported. In 1890 the product had so grown that it was nearly double the value of the imports, and more than double the value of the product in 1880. During the next decade the rate of increase was accelerated. In Paterson is the largest silk-ribbon mill in the world. Another mill in that city, an outgrowth of the little mill operated by John Ryle, covers an acre and a half, and can nowhere be surpassed for size or completeness of equipment. See SILK AND SILK INDUSTRY (*History of the Industry in the United States*).

The consumption of raw silk in recent years is as follows (in pounds): 1914, 25,021,945; 1909, 17,729,306; 1904, 11,572,783; 1899, 9,760,-770. Statistics of the silk industry are given below:

	ESTABLISHMENTS	Wage-earners	Capital	Wages	Cost of material	Value of product
1914	902	108,170	$210,072,000	$47,109,000	$144,442,000	$109,569
1909	852	99,037	152,158,000	38,570,000	196,912,000	89,145

Other important statistics in the silk industry are the following: Amounts of spindles in use: *Throwing* (raw silk) in 1914, 677,960; 1909, 637,565; 1904, 624,686; 1899, 442,410. *Spinning and Twisting* in 1914, 2,023,491; 1909, 1,647,415. *Spinning of Spun Silk* in 1914, 107,251; 1909, 130,547. Thrown and spun silk in 1904 and 1899 amounted respectively to $1,394,020 and $1,213,493.

LOOMS	1914	1909	1904	1899
40 inches or less	26,431	28,426	50,449	36,989
Over 40 inches	44,549	35,214		
Velvet	2,524	1,196		
Ribbon	11,554	10,570	......	......
Jacquard looms	6,826	8,985	......	......

Cotton.—In the textile industry King Cotton still maintains supremacy. And the United States holds a proud position among her fellow-nations. The industry has shown a marvelous growth in the last quarter of a century, but the centres of production have shown frequent reduction of output in individual mills while collectively the advance has been aggressively steady. The first cotton mills were in New England but by 1860 the industry had spread into scattered sections as is shown by the following table which gives New England 52 per cent of establishments and 75 per cent of spindles:

COTTON MANUFACTURES 1860.

ESTABLISHMENTS	Cotton used in pounds	Spindles	Value of product
New England, 572	283,700,000	3,800,000	$79,400,000
Middle States, 540	87,100,000	1,000,000	26,500,000
South, 159	43,900,000	300,000	8,100,000
West, 22	7,900,000	40,000	1,600,000

This New England industry was centralized in Massachusetts and Rhode Island and factories were grouped largely at Providence, Fall River and Lowell with Manchester, N. H., also prominent and Philadelphia the largest cotton manufacturing city. This before the Civil War. The general technical growth up to 1890 has been briefly given above (more details of machinery can be found under title LOOM) with its greatly improved machinery inventions thus allowing larger output per man power, higher wages, and competition with European imports. But the radical changes occurring in the industry are shown by the fact that New England's 570 establishments in 1860 had fallen to 308 in 1905, though the number of spindles had increased from 3,859,000 to 13,911,000 in those years from the tendency of the smaller factories to lose ground and the rapid growth of the more prominent and highly capitalized mills. Then came the sudden mushroom-like growth of the Southern mills and the Northern cotton-mill owners feared that their industry was threatened by the competing field with its low-priced labor. From 1890 to 1905 we get the following statistics which show that the advance of the Northern industry maintained a healthy advance:

VALUE OF PRODUCT.

	1890	1900	1905
Fall River	$24,925,000	$29,286,000	$32,538,000
New Bedford	8,185,000	16,748,000	22,412,000
Lowell	19,789,000	17,046,000	19,384,000
Manchester	10,957,000	11,723,000	14,366,000
Pawtucket	3,955,000	5,635,000	10,099,000
Lawrence	6,047,000	8,151,000	5,745,000
Taunton	2,748,000	4,593,000	6,141,000
New England	$181,112,000	$191,690,000	$224,072,000

The number of establishments in the Southern States in 1860 was 165; by 1900, 550 and of much larger size; and the table following shows the extraordinary growth to 1910:

STATE	Establishments		Spindles		Looms	
	1880	1910	1880	1910	1880	1910
South Carolina	14	145	82,000	4,019,000	1,700	88,427
North Carolina	49	292	92,000	3,174,000	1,800	50,979
Georgia	40	139	199,000	1,939,000	4,500	35,069
Alabama	16	61	49,000	947,000	900	15,853
Tennessee	16	29	36,000	293,000	800	4,391
Virginia	8	14	44,000	329,000	1,300	8,694
Mississippi	8	19	19,000	177,000	600	3,586
Texas	2	16	3,000	112,000	100	2,331
All other	11	16	37,000	241,000	600	2,942
Total	164	731	561,000	11,231,000	12,300	212,272

The product of the Southern mills has been chiefly coarse yarn and cloth while the North has maintained its hold on the finer goods, and it still produces great output of coarse goods.

A general survey of the progress of the United States in its cotton industry is best told by the statistics. Thus we have for woven goods in square yards and values the following figures:*

	1899	1904	1909	1914
Square yards	4,485,605,418	5,056,779,590	6,267,561,279	6,810,712,349
Valued at	$239,668,011	$317,539,626	$447,167,319	$488,728,054

Other interesting figures are: The cotton consumption in the textile mills in pounds:

1914	2,679,934,778
1909	2,465,225,572
1904	1,981,804,446
1899	1,923,704,600

Cotton manufactures in 1914 were valued at $701,300,933; in 1909 at $628,391,813; 1904 at $450,467,704; 1899, $339,200,320. The equipment of spindles producing the above output was in 1914, 30,887,489; 1909, 27,425,608; 1904, 23,195,143; 1899, 19.050,952. These were used on the following number of looms (all classes): 1914, 676,661; 1909, 665,049; 1904, 559,296; 1899, 455,752.

Improved Spinning.— The improvements in spinning have been so rapid since 1870 that most of our large corporations have been compelled to replace their spinning-frames two or three times in that interval. A similar statement can be made regarding no other branch of textile manufacture; and it is probably true that if the American woolen mills had been forced, as the cotton mills have been, to abandon machinery as soon as it became in any degree obsolete, their ability to face foreign competition would be more nearly in keeping with that shown by our cotton manufacturers.

Large Corporations.— The conditions here narrated have thrown the cotton manufacture more and more into the hands of large corporations, which now almost universally conduct it. The wool manufacture, on the other hand, while it numbers some of the greatest corporations in the land, is still largely in the hands of individuals and partnerships, and the bulk of the mills are comparatively small in

* Not including lace, tape, webbing and "other cotton products." which give an added value of $44,186,551 for 1914; $36,936,969 for 1913; $26,454,297 for 1904, and $25,297,385 for 1903.

capacity. The more recent tendency in the wool manufacture, tor obvious reasons, is strongly in the direction of the corporate form of management.

Fine Cottons.— The quantity of fine cotton goods made in American mills continues to be very small in comparison with the whole production, and in the bulk of our consumption of this class of cottons is still imported. So there is ample room remaining for further development of the American cotton manufacture. Into this field we are entering with characteristic Yankee energy. Within comparatively few years mills have been successfully established in New England which spin yarns as fine as Nos. 150 or 200; and there are mills at New Bedford, Taunton and elsewhere which make, in wonderful variety, fabrics as delicate in texture and as artistic in design and coloring as any which reach this country from the machine-using nations of Europe.

Wool.— The range of products made in American wool factories is as wide as the multiform uses to which this most valuable of all the fibres is put. They divide themselves naturally into four great groups, leaving the hosiery and knit goods out of the classification: woolen mills, worsted mills, carpet mills and felting mills. There are the various subclassifications of spinning, weaving, dyeing and finishing mills, although, as a rule, all these separate processes of the manufacture of wool continue to be carried on jointly in this country, as the related parts of the one operation of manufacturing.

men who find the ultimate market for all the specialists who have been thus employed upon the goods. In this specialization of the different branches of the work exists the characteristic distinction between the American and the foreign textile mills of to-day. Investigation appears to show that the English method is far superior to the American, and that ultimately we must gravitate into the former, if we are to cut any figure in competition for the world's market. The manufacturer who devotes his whole energies to one particular thing, and studies to do that one thing as cheaply and as well as it can be done, can do it better and more cheaply than the manufacturer who is doing half a dozen different things at the same time. This is not a theoretical deduction, but an axiom founded upon prolonged experiment and experience. Bradford manufacturers who have tried both methods say there is always a gain in economy when the weaver buys his yarns, instead of spinning them himself. Obviously the English method requires a smaller investment in plant, secures a simpler and more perfect autonomy in operation, involves less waste and avoids the accumulation of superfluous raw material. The American woolen mill was evolved from conditions which rendered specialization originally impossible. It was situated in some isolated spot, drawn thither by a superior water power, with no railroad to facilitate quick transportation, and was necessarily a complete mechanical entity, however crude its machinery. In a word, it must perform under one roof all the processes necessary to convert the greasy wool into the finished cloth ready for the market. Thus there sprang up all over the country little woolen mills, each one independent in itself; as the country grew some of these little mills became large mills; other large mills grew up beside them; gradually grew centres in which the wool manufacture predominated; but conditions were long in appearing which tended to that specialization of processes which has marked the English method from the very introduction of automatic machinery. It followed that the American millowner, even of a small mill, was compelled to make a variety of goods, in order to use up advantageously all the grades of material which grew out of the sorting of his wool. Naturally he could not produce a variety of products as cheaply and as successfully as he could have manufactured one particular line upon which his whole attention was centred. These habits of manufacturing, forced upon us originally by the logic of the situation, are tenacious. We

WOOL MANUFACTURES, INCLUDING WORSTEDS, FELTS, CARPETS, ETC.

	1914	1909	1904	1899
Number of establishments	979	1,124	1,213	1,414
Persons engaged	203,716	209,882	186,699	164,713
Wage-earners	195,285	202,029	186,699	164,713
Capital	$497,699,293	$506,205,584	$370,861,691	$310,179,749
Wages	93,357,880	87,962,669	70,797,524	57,933,817
Cost of material	298,063,498	322,441,043	242,561,096	181,159,127
Value of product	464,249,813	507,166,710	380,934,003	296,990,484
Manufactured product	502,857,333	552,503,710	483,526,095	394,369,523

Specialization.— In the wool manufacture, as in the cotton and silk manufacture, we have many establishments which, in completeness of structure, in perfection of machinery, in all the details of mechanical equipment, and in sagacity of management, are nowhere in the world surpassed. Indeed, it is only in this country that we find, on a very large scale, textile mills in which are performed all the separate processes for the manufacture of great varieties of goods. Elsewhere they have learned that the greatest economy and the best practical results are secured by specializing the processes. Thus in Bradford, England, are enormous establishments which do nothing but comb wool into tops, either on commission or for sale. Other great mills do nothing but spin tops into yarn, and generally they confine their operations to a limited variety of yarns. Still others, buying their yarn, devote themselves exclusively to weaving. And, finally, a fourth class of establishments take the woven goods and dye and finish them for the merchants, who are the have been slowly breaking away from them, but it will be years yet before it is possible fully to outgrow them. In Philadelphia, which is the largest centre of wool manufacture, the progress of the evolution is very perceptible. There they have top-makers, yarn-makers, dyers and finishers, who do nothing else. And the result is apparent in the large number of small manufacturers in that city. The small amount of capital required to equip a little weave-shed permits enterprising superintendents and operatives to start in business for themselves. The comparative cheapness of production under such conditions enables them to hold their own against the big establishments with unlimited capital at their back.

American Woolen Specialties.— The bulk of the small wool manufacturing establishments in the United States are woolen mills proper, as distinguished from worsted mills. It is noticeable that the number and product of these woolen mills decrease from census to census as the worsted manufacture gets more firmly established here, and the more popular worsted fabric comes into wider use. But there are certain lines of woolen goods in the manufacture of which American mills have earned a world-wide pre-eminence. Prominent among them are flannels and blankets of every grade and variety. The American wools are peculiarly suited for these goods, and for many years past our American mills have practically supplied the home market. Other mills make a specialty of woolen dress goods for ladies' wear with equal success. The bulk of our woolen mills are, however, engaged upon the manufacture of cloths for the million — cassimeres, beavers, satinets, cheviots, etc., the cheaper grades which enter into the consumption of the wholesale clothing houses, goods in which, under the weight duties of recent tariffs, our American manufacturers have controlled the home market, and of which their production has been enormous. Many of these goods are woven upon a cotton warp, and into some of them enters more or less of the revamped wool known as "shoddy." We have much to learn, however, in the handling of this class of materials, before we shall equal the expertness of foreign manufacturers.

WOOLEN GOODS.

YEAR	Establishments	Wage-earners	Capital	Wages	Cost of material	Value of product
1914	501	49,165	$107,872,000	$24,204,000	$63,696,000	$103,816,000
1909	587	52,180	120,320,000	22,575,000	65,652,000	107,119,000
1904	792	72,747	140,302,000	28,828,000	87,831,000	142,197,000
1899	1,035	68,893	124,386,000	24,757,000	71,012,000	118,430,000
1889	1,311	76,915	130,990,000	26,139,000	82,270,000	133,578,000
1879	1,990	86,504	96,096,000	25,836,000	100,846,000	160,607,000
1869	2,891	80,053	98,824,000	26,878,000	96,433,000	61,895,000
1849	1,559	39,252	28,119,000	....	....	....

Worsteds.— The worsted manufacture was late in getting lodgment in the United States and has been slow in assuming proportions commensurate with its importance abroad. Early in the forties there were two or three large worsted mills erected in New England for the production of worsted fabrics or stuff goods for women's wear; but the manufacturer made little headway until after the close of the Civil War, and it was not until about 1870 that we began making men's wear worsted goods. Since then the development of the manufacture along both lines has been phenomenal. In the manufacture of fine men's wear goods, both in woolens and worsted, a few American mills have been equally successful; their products sell side by side with the best makes of foreign goods. Another obstacle is the high cost of labor, which counts more strongly in fine wool goods than in the cheaper grades or in cottons and silks, because of the much greater care and skill and labor that must be bestowed upon their finishing. Woolen goods are from carded wool, worsted from combed wool. The popularity shown to worsteds has resulted in a great growth in that class of goods, checking the advance of the manufacture of woolen goods as is shown by the following tables:

WORSTED GOODS.

YEAR	Establishments	Wage-earners	Capital	Wages	Cost of material	Value of product
1914	298	109,527	$281,781,000	$51,749,000	$182,801,000	$92,897,000
1909	324	111,012	295,058,000	47,152,000	207,787,000	104,837,000
1904	226	69,251	162,465,000	26,270,000	109,658,000	56,087,000
1899	186	67,008	132,168,000	77,075,000	120,314,000	43,239,000
1879	76	18,803	20,374,000	5,683,000	22,014,000	11,536,000
1869	102	12,920	10,086,000	4,369,000	14,308,000	7,782,000
1859	3	2,378	3,230,000	544,000	2,443,000	1,258,000

Felted Wool.— The manufacture of felted wool is comparatively small here and elsewhere and the importations are comparatively insignificant in volume. Felted wool was the earliest form into which this fibre was manufactured, the primitive races discovering, before they had learned to spin and weave, that peculiar characteristic of wool which causes it to mat together, by the application of heat, moisture and pressure, into a firm and smooth texture, susceptible of a great variety of uses. Modern machinery has utilized this peculiarity for many purposes which, while limited, are economically important. Tablecloths and floor coverings, and hats for men's and women's wear, are the most ordinary; but they are also used for shoe linings, sheathing materials, polishing purposes, etc. The hat manufacture, formerly confined to wool for its raw material, has found that fur is better suited for this use; and the processes of manufacture are so different from those employed in spinning and weaving mills that the hat-manufacturing establishments, in which the United States has always been pre-eminent, are not ordinarily classed among the textile mills.

Carpets.—Perhaps our most notable achievement in the textile line has been in the carpet manufacture. Beyond question the United States is the greatest carpet-manufacturing nation in the world; if we leave out of account the hand-loom productions of the Eastern countries we excel all others not only in the quantity of our production, but in the variety of our carpets, in the excellence of design and workmanship, and in general adaptability to popular needs. The production includes two-ply and three-ply ingrains, Brussels, moquettes, tapestries, velvets, Smyrnas and the highest grades of Axminsters and Aubussons. The annual consumption of this product by the American people begins to approach 100,000,000 square yards. The popular reason assigned for this unique development is the general prosperity of our people, the high wages earned permitting families of all grades of life to indulge in the luxury of floor coverings to an extent elsewhere unknown. Stimulated by the lucrative market thus offered, American manufactures have made larger and more important contributions to the mechanism of the carpet manufacture than those of all other nations combined. The real development of the machine industry dates from the successful application of power to the weaving of ingrain carpets by the late Erastus B. Bigelow in 1844. Subsequently he invented Jacquard looms for weaving Brussels and Wiltons, which produced carpets pronounced by the jury at the London Exposition of 1851 to be «better and more perfectly woven than any hand-loom carpets that have ever come under the notice of the jury.» A still later invention of Bigelow's was for weaving tapestry carpets. His inventions are at the base of all the power-loom carpet-weaving now done in Europe. Subsequent inventors have greatly improved them and have added new inventions, such as those for weaving Axminsters and Smyrna rugs. By their skill and enterprise the American carpet manufacturers have not only retained the control of their own market, except in the matter of the Eastern hand-made rugs, but they have in some instances successfully forced their products upon the European markets.

In 1914 there were 97 establishments in the United States producing carpets and rugs of other than rags, keeping 33,100 persons engaged; the wage-earners numbered 31,309 and were paid $14,715,615. Capital employed was $85,153,828. Jute carpets and rugs were made to the added value of $1,172,257. Rag carpets produced had a value of $2,786,439. The growth of the industry is shown by the following figures:

	1914	1908	1904	1899
Carpets and rugs (other than rag)				
Square yards	66,340,274	81,218,881	82,670,843	76,410,050
Value	$64,683,322	$66,966,338	$56,861,775	$43,551,158
Spindles				
Spinning mule	102,238	94,798	211,331	167,123
Spinning frame	110,090	116,674		
Doubling and twisting	34,434	40,624	44,016	42,083
Carpet and rug looms				
Power	9,821	11,796	13,853	12,511
Hand	31	207		

Hosiery and Knit Goods.— In one other branch of the textile industry progress in the United States has outstripped the world — the hosiery and knit-goods manufacture. More machine-made knitted goods are turned out annually here than in all other countries combined. The explanation is somewhat the same as in the case of carpets. Our people wear more underwear than other people; they are not only obliged to wear more for climatic reasons, but they can afford to wear more; and the general desire for personal comfort in wearing apparel results in an enormous distribution of the products of these mills. The beginnings of the industry are well within the lifetime of many manufacturers still living. Until 1832 the knitting of socks and stockings remained mostly a household industry — the only form of textile work which the machine had not wrested from the housewife. In that year Egbert Egberts successfully applied the principle of knitting by power, at Cohoes, N. Y. His machine was simply the square stocking-frame of William Lee adapted to power. From that adaptation dates a revolution in underwear, which had previously consisted wholly of flannel, fashioned and sewed at home, according to the individual needs. The revolution gathered momentum gradually, as invention after invention — almost all of American origin — perfected the knitting-machine; but once the new industry was fairly and firmly established, it spread with amazing rapidity. The great variety of goods made facilitates the tendency, peculiar to this industry, toward the building of comparatively small mills, requiring but moderate capital; and it happens in consequence that these mills spring up all over the country and can now be found in nearly every State. Many of them employ only cotton as a raw material; others use chiefly wool; and still others manufacture what are known as merino knit goods or mixed goods — cotton mixed with wool in proportions varying from 50 to 75 and 90 per cent of cotton, according to the particular market sought.' The tendency to the larger use of cotton in these goods is perceptible, not necessarily because of greater cheapness or a desire to adulterate, but because the liability of wool to shrink, and its excessive warmth, lead many to prefer undergarments in which cotton is an equal or predominating material. In 1858 E. E. Kilbourne invented a machine for automatically knitting full-fashioned underwear; and this machine has gradually wrought a second revolution in the industry. The amount of hand labor now done is reduced to the minimum — to the mere sewing on of buttons, so to speak.

KNIT GOODS.

YEAR		Establishments	Wage-earners	Capital	Wages	Cost of material	Value of product
Power machines	1914..	1,491	150,145	$215,357,000	$59,605,000	$146,291,000	$111,750,000
	1909..	1,264	128,708	162,855,000	44,527,000	109,416,000	89,156,000
	1904..	1,079	103,715	106,663,000	31,536,000	76,594,000	59,964,000
	1899..	921	83,387	81,861,000	24,358,000	51,072,000	44,411,000
	1889..	796	59,588	50,608,000	16,578,000	35,862,000	31,379,000
	1879..	359	28,885	15,579,000	6,701,000	15,211,000	13,956,000
Hand machines	1914..	131	375	469,000	153,000	872,000	476,000
	1909..	110	567	786,000	214,000	1,572,000	747,000
	1904..	65	377	280,000	79,000	518,000	323,000
	1899..	85	304	205,000	76,000	351,000	288,000
	1879..	39	1,814	153,000	138,000	447,000	208,000

Linens.— The line of textiles which has found the greatest obstruction in the United States to advance has been linens. The financial condition of this branch was unremunerative and its output, till 1890, when the manufacture of the flax product took on new energy, was nominal. But it has maintained headway ever since, as the statistics show. One drawback has been the difficulty of getting the American agriculturist to grow a flax crop, in spite of placing a high tariff on the raw stuff to tempt the grower. Matters have, however changed considerably already, the industry has obtained a firm foothold and the statistics show steady growth.

LINENS.

YEAR	Establishments	Wage-earners	Capital	Wages	Cost of material	Value of product
1914	21	3,567	$8,810,000	$1,386,000	$4,289,000	$6,960,000
1909	15	3,573	7,457,000	1,213,000	3,967,000	6,385,000
1904	15	3,811	6,294,000	1,325,000	3,741,000	5,856,000
1899	18	3,283	5,689,000	1,037,000	2,551,000	4,368,000
1889	5	1,940	2,734,000	528,000	1,595,000	2,880,000
1879	6	1,414	907,000	384,000	1,132,000	1,892,000
1869	10	1,746	2,325,000	424,000	1,121,000	2,179,000
1859	11	689	840,000	134,000	388,000	840,000

Statistics.— The value of all textile products in the United States for 1850 was $128,769,971 and this had increased to $931,494,566 in 1900. The census report for 1900 shows the following:

The number of cotton spindles in operation in 1900 was 19,008,352, as compared with 14,188,103 in 1890, and 10,653,435 in 1880. This striking increase is due in a large measure to the wonderful growth of the industry in the South since 1880, as before that date the cotton manufacturing industry existed there only on a most restricted scale. In fact, the growth of the industry in the South may be regarded as the one great fact in its history during the past decade. It has been fairly continuous and remarkably steady.

The totals of manufactures in the United States products, etc., in the textile industries follow:

YEAR	Establishments	Wage-earners	Capital	Wages	Cost of material	Value of product
1914	22,995	1,496,644	$2,810,848,000	$672,351,000	$1,993,058,000	$3,414,615
1909	21,723	1,438,446	2,488,463,000	592,261,000	1,745,516,000	3,060,199
1904	17,042	1,156,305	1,744,169,000	419,842,000	1,246,562,000	2,147,441
1899	17,647	1,022,123	1,340,634,000	341,652,000	894,846,000	1,628,606

The extraordinary growth of the exports of textiles from the United States of America is shown in the following table:

	1908	1912	1914	1916	1918
Silk, manufactures of	$720,368	$1,992,765	$2,307,605	$5,204,813	$12,140,750
Cotton, manufactures of:					
Cloth	14,268,083	31,388,998	28,844,627	46,381,390	103,416,102
Knit goods	1,482,751	1,858,836	2,546,822	20,546,822	15,353,165
Woolens:					
Carpets	63,074	57,152	....	....	....

The wonderful strides given in these figures for 1916–18, of course, reflect the consequences of the war cutting off Europe from her exports and the consequent enormous increase of our products in demand from South America and other foreign states.

Future Needs.—The American textile manufacturers have left little to be desired in the direction of cheapening textile products without deteriorating quality. They have built and equipped mills which rank with any in the world. They have planted on this continent machinery enough to supply all the textile wants of our people, except in a comparatively few lines of very fine fabrics. They have managed these mills with rare business sagacity, and as a rule with notable financial success. They have taken one specialty after another which had never been attempted here, and transported its manufacture from across the water, literally inventing anew the necessary machinery, as in the case of braids and plush goods, when they could not obtain it otherwise. They have taken these several textile industries, which have been localized and specialized in Europe for generations, and in less than a century have made them one of the chief corner-stones of our national wealth. They have contributed far more than their share to the mechanical development which makes the labor of a single operative stand for that of a regiment of hand-workers in the 18th century. They have fallen short only in contributing to the artistic side of textile industry. They have been imitators instead of originators, although there are among them many striking and gratifying exceptions to this rule. But American-made goods do not bear, generally speaking, any distinctive artistic characteristics which distinguish them as American-made; and, generally speaking, they are inferior in this respect to the best products of foreign looms. All this is natural — natural to a new country in which utility everywhere predominates over the ornamental. The next great forward step in our textile manufactures must be in the artistic rather than the mechanical direction, for there we recognize its weakest point. In the designing of patterns, in the use and application of dyes, in all that goes to impart to fabrics the artistic element, to lift the manufacture into an art, our textile mills are still far from the top of the ladder. This deficiency is not in any sense peculiar to the textile industries. It is an educational deficiency in which our people as a whole may be said to share. It is incidental to a crude country of limited facilities in art directions. What needs to be done is to supply more facilities.

Trade Schools.— In the centres where the textile industry has grown to be the predominating commercial factor the necessity of having training schools for operative artisans in recent years became obvious to the manufacturers. With the increasing size of the industrial establishments labor became more specialized and operators learned nothing of the technique outside of the special task of tending a machine or some other single restricted sphere of action, quick pace being the compass of the individual operative. Europe had long since filled the need for training expert artisans in all-round textile work to fill the place of chemists, designers, dyers, machinists, overseers, superintendents, etc. In 1872 the Lowell School of Practical Design was established. The Philadelphia Textile School was incorporated at Philadelphia in 1876 and gives a three-year course in all the various processes connected with the manufacture of cotton, wool and silk, including chemistry, dyeing and an ingrain-carpet course. In 1872 the Lowell School of Practical Design was established at Boston, and in 1878 the Rhode Island School for Design was formed in Providence, R. I., to teach technical designing for the textile trade. The Lowell Textile School, at Lowell, Mass., was organized in 1896 to teach all the branches of the industry. The New Bedford Textile School, at New Bedford, Mass., was formed in 1895 and opened in 1899. The Fall River institution called Bradford, Durfee Textile School was founded in 1900. The Industrial School at Lawrence opened in 1907 and provides the workingman with a practical education in the textile trade. And in the South several colleges have opened textile departments such as Clemson College, South Carolina (1898), the North Carolina College of Agriculture and Mechanical Arts, the Georgia School of Technology (1899), the Mississippi Agricultural and Mechanical College (1901) and the Agricultural and Mechanical College of Texas (1905). For further particulars see under TECHNICAL EDUCATION.

Foreign Textiles.— J. A. Hunter, a Halifax expert, said in 1915: «There are 145,000,000 spindles in the world spinning cotton; 56,000,000 are in England, 11,500,000 in Germany. The mule or intermittent spinning machine is the staple producer in England; the ring frame, or continuous machine, accounts for about half the spindles in Germany. . . . In 1907 Germany had an outturn of cotton yarn valued at $157,500,000, the British production $395,000,000 . . . In 1907 (according to the 1907 census) Great Britain wove 397,000,000 yards woolen cloth, Germany 270,000,000 yards. The mule is used in spinning finer yarns and the English, making fine goods, use more spindles, viz.: in 1909 England used 39,000,000 mule spindles against 7,900,000 ring spindles.» In that country spinning and weaving are generally products of different mills whereas the two processes are generally combined in the United States mills. In the ring-frame less skilled labor is required than with the mule hence the former is better adapted to this country. Again the output is greater upon the ring spindle giving, therefore, more output besides allowing cheaper labor.

In 1907 England's output of woolen tissues (all wool or mixed) amounted to 188,125,000 yards valued at $88,000,000. Her worsted tissues (all wool or mixed) were 209,109,000 yards valued at $86,655,000. Other products for that year were:

		Value
Damask, tapestry and other furniture stuffs (yds.)	6,901,000	$3,805,000
Flannels and delaines (yds.)	50,566,000	9,290,000
Carpets (yds.)	25,766,000	16,295,000
Rugs (yds.)	3,813,000	3,195,000
Blankets (pairs)	3,130,000	7,380,000
Shawls (by number)	1,142,000	1,220,000
Other woolen fabrics as coverlets, braids, etc	....	224,425,000

Of England's cotton product we have figures: for 1907: Piece goods 7,087,000 yards valued at about $411,620,000, of which were bleached goods (not dyed or printed) 2,200,062,000 yards; dyed, but not printed 1,142,524,000 yards; printed (dyed or not) 1,326,059,000. Her silks amounted to the following figures:

BROADSTUFFS	Yards	Value
Wholly silk (net or spun)	10,527,000	$4,345,000
Mixed	7,941,000	3,600,000
Made-up goods (neckties, etc.)	....	3,255,000
Ribbons, trimmings, etc	....	6,790,000

UNDERWEAR	Value
Shirts, pants, vests, etc	$13,615,000
Fancy hosiery (including cardigans, sweaters, etc.)	4,525,000
Hose, half hose, etc	22,040,000
Other hosiery	860,000
Gloves (cotton, wool, silk, etc.)	2,150,000
Entire quantity of hose made in 1907	72,045,000

England's exports were:

	1916	1917
Cotton piece goods	$443,939,450	$564,052,485
Other cottons	74,175,115	78,434,900
Wool manufactures	234,528,245	264,238,370
Silk	12,030,590	10,090,280
Other manufactured fabrics	79,089,715	84,719,850

In 1840 Germany had 658,358 spindles working which grew by 1860 to about 2,000,000. A recent report gave her 10,920,426 spindles for cotton spinning. In Crefeld, the centre of Germany's silk industry, were at last reports (1914) 65 factories making silk cloths and 28 factories producing velvets. The total German silk product has been estimated at about $29,013,833.

According to the last statistics available France had 7,500,000 cotton spindles. These were chiefly located, before the war, at Lille, Roubaix, Tourcoing, Epinal, Saint Dié, and in Normandy, at Rouen, etc. They employed about 130 power looms and 40,000 hand. Her silks were chiefly produced at Lyons for high quality goods. Silks of fine quality were also made at Saint Etienne and in Picardy. The Lyons industry employed from 85,000 to 90,000 operatives on over 20,000 power looms. They produced 2,500,000 kilograms of wrought silk and 1,000,000 kilograms raw silk. Production follows:

	Products valued at	
Lyons	409,000,000 fr.	$81,800,000
Saint Etienne	8,205,000	1,641,000
Picardy	4,600,000	920,000

in all about $84,361,000.

Foreign Schools.— England's textile operatives are supplied with technical training in such schools as Bolton Technical School, Bradford Municipal Technical College, Coventry Municipal Technical Institute, Halifax Municipal Technical School, Huddersfield Technical College, Keighley Institute, Yorkshire College at Leeds, Oldham Mutual Technical School, Rochdale Municipal Technical School, Salford Royal Technical Institute, etc. Germany has textile schools at Aix-la-Chapelle, Crefeld, Cottbus, Falkenburg, Muhlheim-on-Rhine, Berlin, Chemnitz, Muhlhaus, etc. In France technical education for the textile industries is given at Elbeuf, Tourcoing, Roubaix, Saint Etienne, Lyons, Flers, Sedan, Bohain. In Austria are textile schools at Asch, Schoenberg, Warnsdorf, Ruthenberg, etc. In Switzerland are textile schools at Wattwyl, Zürich, etc. In Italy we find such at Prato, Arguno, etc.

TEXTILE PRINTING. The decorating of fabrics by printing is one of the oldest of the arts. There are evidences that it was practised in Egypt 2000 B.C., and it was used in ancient Assyria, India and China. Opinions are divided as to the country of its origin, but there is no question that it came to mediæval Europe from India. Rich patterns of both silk and cotton were brought by early traders to the leading ports of Europe and inland. German manufacture appears to have begun in the 13th century. They printed principally silks and linens, and were addicted to gilt and silver designs. In the course of time the art spread to Switzerland, France and England. The print works at Jouy, near Versailles, France, were the first to become famous there. It is believed that fabrics were printed in England as early as 1620, but the first record of systematic manufacture was at Richmond-on-Thames in 1690. All this early printing was done from blocks by a method very similar to block printing for books. The designs were cut in the surface of a block, and if many fine lines were desired, the surface of the wood was cut away and thin strips of copper twisted and cut to the required form for the lines, and forced tight into the wood until the top of the copper was at the desired level. If a large solid surface of color was required, it was found better to surface the wood with felt, as it carried the ink better than the wood. That very beautiful results can be had by block printing on fabrics is evidenced by the fact that it is still practised by amateurs as a fad and by a few artistic workmen in large cities. Block printing was long done entirely by hand, the cloth being laid on the inked block, covered with felt or the like and impressed with a mallet or by rubbing. But presses for block printing became common in England in the 18th century and continued to be used long after the cylinder method of textile printing came into use. Several had the idea of printing with a roller, but Thomas Bell, of England, was the first to bring out a practicable cylinder machine, in 1783. His object was twofold, to print several colors at once and to do away with bad joints, which were all too common in block printing, wherever the pattern repeated. In 1785 he patented a six-cylinder machine, which was the prototype of the modern cylinder cloth-printing machines. Though vastly superior, the invention was accepted slowly, and in 1840 it is reported that there were but 516 cylinder machines in Great Britain as against 14,000 tables for block printing. Engraving on the cylinders was for a long time tedious and expensive, the first radical improvement here being Gormetz's engraving machine in 1828. The pantagraph machine for duplicating patterns on cylinders in enlarged size came in 1834, and thereafter the art of textile printing advanced very rapidly. The patterns or designs are now made on paper and transferred to the cylinders, and either cut in with the pantagraph or etched on copper. They are also sometimes made in soft steel and later hardened. A modern cylinder textile press has a great central drum around which the cloth travels. About this drum are a series of engraved cylinders with inking apparatus. The cloth is led in from a reel and passes under perhaps six or eight cylinders, receiving a color impression from each, in exact register, and is then led to a drying apparatus, that is commonly an enormous reel, with adjustments for keeping the printed surfaces apart until quite dry. Commonly the colors are put on lightly for surface effect, and in other cases the color is forced through the cloth, so as to get an effect on the reverse side. Most exquisite printing is done on silks, linens, woolens and cottons, as can be seen by any one who will visit the counters of any large dry-goods store. The tapestries, draperies, figured dress goods, cloths for upholstery, etc., produced by this process are endless, involving all the colors of the rainbow; in fact the perfection attained in the art is truly amazing. Consult Rothwell, 'Printing of the Textile Fabrics' (Philadelphia 1892); United States Bureau of Manufactures, 'Reports' on Cotton Goods (1912); Knecht and Fothergill, 'Principles and Practice of the Textile Printing' (London 1912); Beaumont, 'Color in Woven Designs' (1912). See TEXTILES; WEAVING.

TEXTILES, or TEXTILE FABRICS. Stuffs made by the weaving together of threads of any sort, so as to produce a material with a nearly solid surface. A fishing-net or the like is not a textile fabric because the cords which compose it are not woven together, but cross one another at equally distant intervals and are strongly knotted at those points. But mosquito-netting is a textile, although very open, because the threads are merely held by their own friction. On the other hand, if a basket is made by weaving together strips of wood or bamboo, such a material is hardly called a textile, but this merely because of its totally different usage. The cane seat of a chair is as truly woven as a piece of muslin or silk.

Textiles in the usual sense are made of the twisted fibres spun into thread of flax or linen, cotton, hemp, jute, silk or wool. The simplest weaving is that which produces our common cotton and linen cloth; that is to say, the threads are merely woven together, one up and one down, and all in the same manner, except that at the edge on either side of the piece what is called a selvage is produced to prevent the raveling out of the threads. From this to the most complicated fabric like brocade the differences are almost infinite, and it is only with the most elaborate diagrams and the fullest explanations that the process of weaving a figured *broché* silk or a velvet with patterns of pile upon pile can be explained. Carpet weaving (see CARPET) differs somewhat from ordinary textiles, and tapestry differs yet more and is often excluded from textile fabrics altogether.

The general nature of a loom is that the threads of the warp are divided into two sets, one of which is thrown upward, while the other is thrown down, and at the same moment a shuttle carrying a thread of the woof is driven through between the two sets of warp threads. The next movement of the loom reverses the two sets of warp threads, throwing the upper one down and the lower one up, compressing and drawing tight the woof thread into the loops which show on the surface of the stuff and go to form the surface, and the shuttle is driven through again in the opposite direction. The constant repetition of this forward and backward movement of the shuttle gives a strip of woven fabric which continually grows broader; and as each movement of the shuttle is made, an appliance drives the last thread of the woof back against the others, so that this growing strip of woven stuff is kept at a uniform state of firmness and solidity. It is in this way that the simplest fabrics of linens and cottons are made. If it be desired to produce a somewhat more elaborate weave, such as twilled material, this is done by raising two threads of the warp and dropping one; or by raising three threads of the warp and dropping one, and so on. In this way, as is evident, the threads of the woof are seen lying in loops or what seems to be stitches longer than those of the simplest weave, and these longer loops arrange themselves in a steplike diagonal across the woof of the stuff. It is clear that, by the increasing complications of such alternate liftings and lowerings of the warp threads, more patterns may be made. If, then, the threads of the woof are of a different color from those of the warp, there is produced a surface whose general color is half way between the two colors of warp and woof. If we take a step further in complexity and use three or four warp threads say, of red, while the rest remain white, and do the same thing with the woof threads, we produce stripes three or four threads wide; and where these stripes cross one another there will be a little square of the solid color of the three or four threads, while the stripes elsewhere remain of the halfway tint alluded to. Again if three threads of different colors are passed by the shuttle at one time, the threads of the warp also being grouped in threes, there will result a simple alternating pattern, which is often very attractive. Indeed, much of the primitive designing of early races is based upon such very simple productions of the loom; for it seems that the mind of man is never tired of a pattern produced by up and down, in and out, in their different combinations. In the most complicated pattern of a brocade, such as the Japanese send us occasionally, in which a row of dragons will alternate with a row of representations of «the sacred pearl» with its flames, and those again with a row of kylins or other fabulous monsters, all being interspersed with elaborate leafage, open flowers of the camellia and bursting fruits of the pomegranate, the same being reproduced in many colors — even in such a complex pattern it is readily seen that these figures are arranged in regular sequence, and that the colors are introduced in a definite and unalterable succession. Thus a blue thread of the woof may not appear more than once in each flower, of a certain row across a piece of stuff, and this appearance of the blue thread may be for a loop of a quarter of an inch long only, while all the rest of that blue thread is found to be hanging loose behind the finished fabric. Again this blue thread may not appear at all in six or seven inches of the length of the stuff, and then it may supply a wholly different detail of the pattern. Still that blue loop in the design as seen from the front or «right side» is found in each one of the flowers or animals which form the cross row of the pattern; and in the next row of similar flowers or animals (which may be two feet away in the length of the piece) this blue thread may be replaced by a crimson one, which will also appear at exactly the same intervals and at exactly the same point in each one of the flowers, or of a unit of design. It is interesting to take a piece of very rich fabric with an elaborate pattern and to examine it with a view to just such peculiarities of weave. Anyone who has watched a simple loom at work and has mastered the process may then understand in great measure the workings of the far more elaborate loom of the silk weaver, who is producing patterned fabrics.

In such weaving of patterns it is here assumed that the threads are dyed before the weaving is begun. The matter of printing colors upon calico, thin silk or the like is entirely apart from the consideration of textile fabrics. Printing is done from blocks with color, almost exactly as if the material receiving the pattern were paper instead of a woven stuff.

The simplest weave made in this way with colored threads is gingham, the name of which comes from the East, probably from India, with the invention of the weave itself. Checks, plaids and stripes are the natural patterns of gingham, but it is also practicable to produce various zig-zag and frets, and the stripes themselves may be variegated by patterns on their surface. Weaves of Persian and Chinese origin with threads and softer and more woolly than European twisted cotton threads are sometimes very attractive in color effect, woven exactly as gingham is woven.

Damask linen, such as is used for tablecloths and napkins, is peculiar in that the pattern is an elaborate twilled fabric in which the twill is arranged to make a pattern — often even of flowers and leaves. These patterns are seen merely by the difference of reflection of light upon the threads of the linen; for those threads which lie parallel in one direction seem brilliant from a given point of view, while those lying in the other direction look dusky. A change of the position of the beholder reverses this effect of light and dark. Moreover it is common that the same pattern is seen in reverse on the other side of the fabric. There is nothing to prevent damask linen being woven with dyed threads in parts of the composition, and occasionally tablecloths of such material come into fashion.

Brocade, a term generally used for very splendid material, means primarily a stuff — composed in part of threads which lie on the surface of the finished stuff (French *brochés*), appearing where the particular color is needed and disappearing again, as explained in the paragraph above. A brocade may be composed of threads all of one color. Thus the silks called *damassé* (French *Damassés*, or *Damassées*) have perhaps a pattern of dark green leaves relieved in shining threads upon a background of exactly the same dye, but looking different because of the different and less glistening character of the threads; this being caused not by the silk being differently spun, but because of the different treatment of the thread in the loom, the long loops lying flat and loosely, and reflecting the light in a different way from the hard pulled threads of the background.

Satin is a material with a silken surface of unusual and uniform glossiness, which is produced by alternately «raising and depressing four yarns of the warp across the whole of which the weft is thrown by the shuttle.» It will be noted that this is a modification of twilling, and the threads of satin are seen to lie in the same way as those of a twilled cotton. It is evident that such a surface is capable of many modifications. Thus there are some fabrics of silk and wool, or silk and cotton, in which the silk threads are thrown to the surface, lying in very narrow stripes or bands, which show glossy on the background, which also show only in very narrow stripes between the others. These fabrics take different names from year to year.

Again, there are Eastern brocades in which the background is composed entirely of the warp threads in a satin weave of one color; while the flowers of the pattern are made up entirely of the woof threads and these in many colors with gold.

There remains to be mentioned those weaves in which the warp threads only are seen in the finished stuff. The most common form of this is ordinary ribbed silk, in which the warp threads form loops (silks called gros-grain and by other special names), giving a rib running across the stuff. Thus a silk in longitudinal stripes of darker and lighter green, buff and brown, has all its woof threads of a dull brown; while the warp threads of the four colors named form visible ribs in which the colors are alternated in a very elaborate fashion, so that one stripe is made up of a small check in two colors, another is plain and solid, of one color; and in all this the only effect of the dark woof is to modify slightly the hues of the stripes by showing between the warp threads.

Velvet is made by carrying the threads of the warp over a rod called a needle, so as to produce a series of ridges or «ribs,» much as in the last paragraph; and then cutting all these ridges by a sharp instrument passed in as the «needle» is withdrawn. This cutting leaves the threads standing up to form the nap or pile, but they are left of different lengths or heights, and, therefore, the whole surface is most carefully sheared and sometimes this shearing is helped by singeing. Fustian, velveteen and corduroy are made by the same process. Plush is a material of the same character and produced in nearly the same way. When the ribbed surface is left without being cut, the term «uncut velvet» is used. This may be used for a part of the surface, while other parts are fully cut and brought to the smooth surface common to velvet. In this way most elaborate patterns are produced — figures being in the velvet pile upon the ground of uncut velvet. Again this may be carried further in producing what is called «pile upon pile» velvet, in which the pile of one part of the pattern is relieved upon the shorter pile of another part of the pattern and this again upon the uncut background. It is evident that such stuffs are of great cost. The beauty of the pattern may also be enhanced by the use of different colors. Thus the velvets of Genoa and of Venice of the 17th century and modern copies of the same may have a general surface or background of a satin-like texture, upon which the flowers and leaves of the pattern are raised in uncut velvet in ridges made of projecting loops, and upon this again is relieved a pattern of cut velvet, smooth and uniform in surface; both these surfaces, the uncut and the cut velvet, being woven with three, four or five colors, the threads being dyed beforehand in dark and light green, crimson, buff and the like. The resulting pattern will be of extraordinary richness, effective at a distance and also near at hand. Such pieces made in Venice at the close of the 19th century would cost about 60 francs a yard when woven 20 inches wide.

The further elaboration of decorative weaving by the introduction of other materials than those of twisted threads, is also of importance. Thus «gold thread,» as it is called, is commonly made of silver wire gilded and then pulled out or «drawn,» the silver and gold together, until it is very fine. This is apt to tarnish, the extremely thin gold disappearing with wear, and the silver not having the power of resisting impurities in the air. To avoid this, where a permanently metallic effect is desired, gold paper is used by the Orientals, the paper being sometimes brown, as it shows on the reverse side of the stuff, and the gilded surface showing on the right side. The less expensive Japanese brocaded silks are often woven in this way. On the other hand, the tarnishing of the metallic gold thread often adds a special charm to the effect of ancient stuffs.

As textile fabrics have been used by all men more advanced than the most degraded savages, the history of textiles is of infinite extent. Even textiles of decorative purpose, those woven in a somewhat complicated way, are of unknown antiquity. Decorative stuffs have been found in Egyptian tombs of very early epochs. The tombs of the lost races of South America have been found to contain beautiful weaves. The earliest painted vases found in Egypt show boats with sails, and although some of these sails were perhaps of skin, there are others in which the evident purpose has been to show a woven material. Western Asia has always been the home of the most beautiful designs in weaving, for at a very early time the people of the great plain through which the Tigris and the Euphrates run were producing fabrics with the most varied and splendid patterns. This tendency to use the Asiatic feeling for color decoration in work with the loom took two different forms in later times. The carpets and rugs woven with pile were brought from Syria into Europe at least as early as the 8th century A.D., and at a later time they were somewhat common in Europe, as is clear from the earlier Italian paintings, in which rugs of unmistakably Eastern design are seen to cover the foot-stool or the throne of a sacred personage. Other heavy stuffs used in the West for floor cloths and also for door and window curtains under the general name of kelim are woven without pile, the patterns being, therefore, much simpler, akin to those described above in connection with gingham and especially with twilled materials. Brocades of different kinds, and also solidly woven, very durable silk stuffs made with threads dyed of different colors, but woven in such minute patterns that the thread nowhere shows as *broché* on the surface, have been made for so many hundred years that the time of their introduction is hardly ascertained. Cotton stuffs woven in a similar fashion with very pretty effects of simple patterns are but little imported to Europe, but their use in the East adds a great charm to the popular costume. Finally the printing of cotton cloths with wood blocks has been practised for centuries, the pattern being admirably drawn and composed and the colors always interesting except where the effect of European commerce has been, first, to substitute the cheaper chemical dyes of Europe for the more permanent and more beautiful dyes of the East, and, secondly, to debase the color design through the orders given by the agents of Western importing houses. The growth of a beautiful textile industry in Europe and the United States is made difficult by the rapid changes of fashion which themselves are brought about by the great desire of large manufacturers to produce the material and the effect which will attract buyers. This tendency is aggravated by the unwillingness of the great dealers to keep in stock fabrics which are out of fashion, because they are very numerous, because a considerable stock of any one would be a troublesome thing to house and to show on occasion, and because «it costs too much to sell» goods that are not in constant demand. Everyone knows how often the material which at a certain time he found to be exactly what he needed cannot possibly be obtained a few years later. See WEAVING.

Bibliography.— The greater number of the books devoted to this subject are collections of plates, often in color and beautifully printed. These, however, give merely the design, while the nature of the stuff can only be guessed. It is rare that any discussion of the fabric or of the manufacture accompanies the plates. The best of these books is Fischbach's 'Ornamente der Gewebe.' The works on Costume (q.v.) often contain much of the same material. For Eastern carpets, Lessing's 'Alt Orientalische

Teppichmuster' (Berlin 1877) gives a number of fine designs collected from paintings of the Renaissance. Vincent Robinson's 'Eastern Carpets' (London 1882), and the second series of the same (London 1883), present a number of admirable specimens belonging to the author, who was a dealer on a large scale and also a collector on his own account. The colored prints are from excellent original drawings. Several books on Eastern rugs have been published during the last few years, of which we name Mumford's 'Oriental Rugs' (New York 1900). The beautiful stuffs known to have been used during the Middle Ages are treated by Francisque-Michel in 'Recherches sur le commerce,' etc., 'Des etoffes de soie,' etc. (2 vols., Paris 1852), and by Dr. Daniel Rock, in 'Textile Fabrics,' the South Kensington illustrated catalogue (London 1870). The same author has supplied the 'South Kensington Handbook' (London 1876). Fr. Bock's 'Geschichte der liturgischen Gewänder des Mittelalters' (Bonn 1859–71) is the standard work on the subject of church ceremonial garments, constantly cited by all writers. One of the most valuable works for the student of the technical side of textiles is 'The Draper's Dictionary,' by William S. Beck (London n.d.), and the modern fabrics in common use are intelligently treated by Caulfield and Saward in the 'Dictionary of Needlework' (London 1885), and also by Lady M. Alford in 'Needlework as an Art' (London 1886); Matthews, J. M., 'Textile Fabrics: Their Physical, Microscopical and Chemical Properties' (2d ed., New York 1907); Kinne and Cooley 'Clothing and Textiles' (ib. 1913); Woolman and McGowan, 'Textiles: A Handbook for the Student and Consumer' (ib. 1913).

RUSSELL STURGIS.

TEXTUAL CRITICISM, the science by which the texts of ancient writings are examined so as to decide upon their authenticity, their completeness and the degree of exactitude with which they represent the original words of the assumed author. This is sometimes called the Lower Criticism as distinct from the Higher Criticism; the former is destructive, or at least negative, in its results. The Higher Critic is constructive and builds up a theory regarding the nature, object, origin and authorship of a literary monument founded upon the material furnished by the Lower or Textual Critic. (See BIBLE — TEXT CRITICISM, Vol. 3, pp. 629–651; BIBLICAL CRITICISM. Vol. 3, pp. 669–671; ESCHATOLOGY, Vol. 10, pp. 490–493, and related references). Consult their bibliographies, also Cheyne, T. K., 'Critica Biblica' (1903); Driver, S. R., 'Introduction to the Literature of the Old Testament' (1891; 6th ed., 1897); Ginsburg, C. D., 'The Massorah' (1880–85) and 'Introduction to the Masoretico-critical edition of the Bible' (1897); Langlois, C. V., and Seignolos, C., 'Introduction to the Study of History' (1898); Loisy, A., 'Histoire critique du texte et des versions de la bible' (1892); Orr, J., 'The Problem of the Old Testament considered with reference to Recent Criticism' (1906); Smith, G. A., 'Modern Criticism and the Preaching of the Old Testament' (1901); also Barnes, H. E., 'History: Its Rise and Development,' Vol. 14, pp. 205–264; and Walsh, J. M., the histories of each century from the 1st A.D., to the 19th, in this work.

TEXTURE, as a term applied to rocks, signifies the size and mode of aggregation of the mineral particles that make up the rock, in contrast to structure, which applies to larger features, such as bedding, joints. etc. A brief description of those textures which are particularly useful in classifying rocks will be found in the article on ROCKS, in the section on *Igneous Rocks.*

TEZCUCO, tās-koo'kō, or **TEXCOCO,** Mexico, a town in the state of Mexico, situated on the northeast shore of Tezcuco Lake, 16 miles northeast of the national capital. The modern town has many handsome buildings, a number of manufacturing establishments and railroad repair shops. Cortes stopped here for a period in 1521 when he besieged Mexico. Tezcuco was one of the three confederated Aztec pueblos of the valley of Mexico, and for a time was the chief among them, yielding later the first place to Tenochtitlan. In its neighborhood are several ancient ruins, including remains of teocallis. Pop. about 6,000; (2) commune surrounding the town; pop. 16,000. (3) District in the state of Mexico, separated from the capital by a large lagoon; pop. about 60,000. (4) Lake or lagoon about four miles east of Mexico City, 13 by 9 miles, very shallow and surrounded by swamps.

TEZIUTLAN, tā-sē-oot-län', Mexico, the capital of a district of the same name in Puebla state, 50 miles from the Gulf and 12 miles east of Zacapoaxtla. Pop. of town, 8,200; of district, about 25,000.

THACH, Charles Coleman, American educator: b. Athens, Ala., 15 March 1860. He was educated in the schools of North Alabama and at the Alabama Polytechnic Institute from which he was graduated in 1877. He also pursued graduate work at Johns Hopkins University 1880–81. In 1881–82 he was professor of modern languages in Austin College, Texas, and from 1885 librarian and professor of English in the Alabama Polytechnic Institute. In 1902 he was chosen president of his alma mater which has long been the foremost scientific institution of the Southern States. President Thach has greatly expanded the institution since he became president. He was a member of the Alabama History Commission 1898–1900, whose report resulted in the establishment of a Department of Archives and History for Alabama. He is also a member of the State textbook commission and the Rhodes scholarship commission.

THACHER, James, American physician and surgeon: b. Barnstable, Mass., 14 Feb. 1754; d. Plymouth, Mass., 26 May 1844. He studied with Dr. Abner Hersey in Barnstable and in 1775 was appointed surgeon's mate in the Cambridge Hospital under Dr. John Warren. The following year he was made surgeon's mate in a regiment stationed on Prospect Hill and marched with it to Ticonderoga where he was attached to the general hospital while the place was held by the Continental army, retiring with it in charge of the sick and wounded to Fort Edward and to Albany. He was transferred to the field service at his own request, was made chief surgeon to the

First Virginia regiment in 1778 and the following year was transferred to a New England regiment. He was with the Continental army until the surrender of Cornwallis and was noted for his skill as a surgeon and for his lofty patriotism. On retiring from the army after the war he practised in Plymouth and became well known by his scientific and literary pursuits. He was the author of much professional and literary work. His ‹Military Journal during the American Revolutionary War› (1823) is an authority on that troublous time and is notable for the vindication of Washington for his conduct toward André. Other noteworthy publications are ‹Observations on Hydrophobia› (Plymouth 1812); ‹American Modern Practice› (Boston 1817)· ‹Practical Treatise on the Management of Pus› (1829); ‹American Medical Biography› (2 vols., 1828); ‹Essay on Demonology, Ghosts, Apparitions and Popular Superstitions› (1831); ‹History of the Town of Plymouth› (1832); ‹Observations Relative to the Execution of Major John André as a Spy› (1834).

THACHER, John Boyd, American writer: b. Ballston, Saratoga County, N. Y., 11 Sept. 1847; d. 1909. He was graduated from Williams College in 1869, and was a New York State senator 1884–85, and mayor of Albany, N. Y., 1886, 1887, 1896, 1897. He was an officer of the World's Columbian Exposition and became chief of its bureau of awards. His publications include ‹The Continent of America, Its Discovery and Its Baptism› (1896); ‹Charlecote — Or the Trial of William Shakespeare› (1896); ‹Little Speeches›; ‹Awards›; ‹Christopher Columbus, His Life, His Work, His Remains› (3 vols., 1903–04); ‹Outlines of the French Revolution Told in Autographs› (1905), etc.

THACHER, Thomas Anthony, American educator: b. Hartford, Conn., 11 Jan. 1815; d. New Haven, Conn., 11 April 1886. He was graduated from Yale College in 1835 and for three years taught in Connecticut and Georgia schools. In 1838 he became a tutor in Yale where he was chosen as professor of Latin in 1842 which position he retained until his death. During a sojourn in Germany he taught English to the Crown Prince of Prussia and to his cousin Prince Frederick Charles. Returning to Yale in 1845 he became active in college work and an important member of the faculty. He was famed as a classical scholar and wrote frequently on his specialty for various periodicals. He assisted in the compilation of Webster's dictionary and edited many Latin classics, notably Cicero's ‹De officiis› which he annotated (New York 1850). He also translated Medvigs' ‹Latin Grammar› and he wrote a ‹Sketch of the Life of Edward T. Herrick› (New Haven 1862).

THACKERAY, William Makepeace, English novelist: b. Calcutta, 18 July 1811; d. London, 24 Dec. 1863. His father, Richmond Thackeray, who was a judge and collector of revenues in India, came of a good Yorkshire family. His mother was Anne Becher, a Calcutta beauty belonging to a family well known in the India civil service. Richmond Thackeray died in 1816; William, his only child, remained with his mother for a year and was then sent to England to be educated. Five years later his mother, who had married Maj. Henry Carmichael Smyth, came to England with her second husband. Thackeray's relations with both were in later years exceedingly charming.

The little boy, who during his voyage had seen Napoleon at Saint Helena, was placed in charge of an aunt, and soon showed precocity. He was put to school under a Dr. Turner, where he is said to have got hints for the opening of ‹Vanity Fair,› and in 1822 he was entered at the famous Charterhouse. Here he remained six years, imbibing loyalty to the memory of such former scholars as Addison and Steele, watching and engaging in fights such as he described later — in one of these his friend George Stovin Venables broke the nose of the future novelist, who was growing up to his great height of six feet, three inches — reading and writing poetry, devouring novels, and making sketches — in short, doing everything but grounding himself in the classics as his schoolmasters wanted him to do. Although he was a good Horatian, he remained to the end a strictly modern spirit.

After studying a little under his stepfather and, perhaps, having some of the experiences described in the early pages of ‹Pendennis,› he went up to Cambridge in February 1829, matriculating in Trinity College. Here he read widely, particularly in the literature of his favorite 18th century; but he evidently preferred to the regular academic routine supper-parties the society of such fellow-students as the Tennysons, Arthur Hallam, Spedding and R. C. Trench (q.v.). He also tried his hand at college journalism, writing parodies and other skits in the weekly *Snob.* In short, he went his own gait, which was a trifle, but not injuriously, unsteady. He left Cambridge after two years of residence without taking a degree.

He had already during his vacations submitted to the charms of Paris, and, with his natural turn for art, he had little inclination to follow his relatives' advice that he should study law. His income from a fortune left by his father, perhaps £500 a year, was ample for his needs, so he resolved to travel and study on the Continent. In 1830 he spent some months in Weimar, where he saw Goethe and learned enough of the ways of natives and travelers to describe ‹Pumpernickel› in after years. His studies, whether of literature or of the civil law, do not seem to have been exhaustive or exhausting.

By the close of 1831 he had returned to England and began the study of law in the Middle Temple. Trips to Cambridge, visits to the theatre, pipes with Alfred Tennyson and Edward FitzGerald (q.v.), and light reading seem to have distracted his attention from Blackstone, but the Temple itself impressed him as every reader of ‹Pendennis› knows. He also did some electioneering for his friend, Charles Buller, and formed an acquaintance with that interesting writer, William Maginn (q.v.), which probably led later to his introduction to the group of men who were making *Fraser's Magazine* popular. When he came of age he closed his law books and spent some time in Paris. Then he took up definitely a literary career, becoming interested early in 1833 in the

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National Standard. He soon bought it and went to Paris to act as its correspondent, contributing also stories and reviews, which in recent times have been unnecessarily exhumed. The venture proved unsuccessful, and Thackeray, who had lost money by it as well as by bank failures and by gambling (he had met his own «Mr. Deuceace») seems to have felt compelled to try seriously to make his living. He had always had a turn for drawing, inherited probably from his father, and he determined that the life of an artist in Paris would suit him admirably. Accordingly in 1834 he established himself in that city, and although he acquired no great skill in his new profession, he enjoyed the society of relatives and friends and laid up knowledge of the French capital which he afterward put to good use in his 'Paris Sketch Book' and in 'Philip.' He seems also to have begun his contributions to *Fraser's Magazine* by 1835, if indeed he did not contribute to it in August and September 1832, the burlesque of Bulwer's 'Eugene Aram' entitled 'Elizabeth Brownrigge,' an early study precluding 'Catherine' and 'Barry Lyndon.' Early in 1836 he was working on a Paris newspaper; then, again in conjunction with his stepfather, he helped to start a new newspaper in London, *The Constitutional,* which did not survive a year. Thackeray, who had previously issued his first separate publication, the eight satirical drawings entitled 'Flore et Zéphyre' (1836) acted as Paris correspondent once more, and seems to have taken his duties quite seriously. It was time, for on 20 Aug. 1836 he had married at the British embassy at Paris a young lady of Irish family who had fascinated him by her singing, Miss Isabella Gethen Creagh Shawe. The imprudence of the marriage became all the more apparent when it was found that *The Constitutional* had swallowed the remains of Thackeray's fortune; but he would never admit his rashness and he worked hard enough ever after in support of his wife and children to be absolved from all reproaches.

He appears to have written for *Galignani's Messenger,* and then to have gone to London, where his first daughter (afterward Mrs. Ritchie [q.v.]) was born. He reviewed books for *The Times* and contributed articles and stories to *Fraser's* and other magazines, displaying an abundance of energy and cleverness, but, partly through anonymity and the use of pseudonyms, attracting little attention. From November 1837, to August 1838, the 'Yellowplush Correspondence' appeared in *Fraser's* and later in the latter year was pirated in America, a country which appreciated Thackeray before England did. There was surely enough humor and satiric power in his early work to have gained it more cordial recognition; but there was also much irony, which rarely makes a writer popular, and there were attacks on favorite authors like Bulwer that could not have been relished in some quarters. At any rate it seems certain that when in 1839 N. P. Willis (q.v.) engaged him to write for *The Corsair,* a short-lived New York weekly, Thackeray was almost as unknown as his younger rival, Charles Dickens, was famous. The ironical 'Catherine,' which finished its Course in *Fraser's* in February 1840, and ought to have shown contemporaries how well its author knew the 18th century and could follow the lead of Fielding, the two volumes of the 'Paris Sketch Book' (1840), and the abruptly ended 'Shabby Genteel Story,' the germ of 'Philip,' were all creditable to 'Mr. Michael Angelo Titmarsh,' as Thackeray had begun to sign himself, but were not yet unmistakable products of a mature genius.

'A Shabby Genteel Story' was cut short by the severe illness of Mrs. Thackeray, which followed the birth of her third daughter, later Mrs. Leslie Stephen. On returning from a trip to Belgium her husband found her strangely changed in mind. There were hopes that she might recover, and Thackeray gave her very constant attention, at home, in Ireland and on the Continent; but it was of no avail. She was finally placed with a kind family and survived her husband about 30 years. The two little girls, for one daughter had died in infancy (cf. 'The Great Hoggarty Diamond,' 1841) were sent to his mother in Paris, and Thackeray set himself to work all the harder in order that he might ensure their support and that of his wife, should his own life be cut short. He had no thought of freeing himself by law, and, although suffering deeply as such a tender-hearted man was bound to do, he went about his work cheerfully, solacing himself as well as he could with club life and enjoying Bohemian haunts such as the «Cave of Harmony,» described in 'The Newcomes.'

In 1841 he published his interesting small volume 'The Second Funeral of Napoleon' and collected his 'Comic Tales and Sketches,' unsuccessfully in both cases. In 1842 he made a tour of Ireland, which yielded materials for his 'Irish Sketch Book' of 1843, and also for a much better book finished at Malta in 1844 at the end of the voyage to the East described in 'Notes of a Journey from Cornhill to Grand Cairo' (1846). This better book was a story which has never been widely popular, but which competent judges have pronounced to be the best of Thackeray's works, 'The Luck of Barry Lyndon.' It was published in *Fraser's* in 1844 and did not meet with enough favor to warrant its being put between covers until 1856, long after its author had become famous, when it appeared in the third volume of 'Miscellanies in Prose and Verse.' The public has never liked a villain for a hero and is uncomfortable in the presence of a writer with a genius for irony, hence Thackeray's masterly memoir of an irrepressible Irish rascal, although it gives a brilliant picture of European life, high and low, in the 18th century and is perhaps inferior only to 'Jonathan Wild' as a piece of sustained irony, will probably continue to be praised by the critics and eschewed by the general reader.

Meanwhile Thackeray had formed a connection that gave him not only a reliable source of income, but also an organ in which he could publish anything he cared to draw or write, with the result that his creative faculty was stimulated and made copious. From June 1842 until 1851 he was one of the most important members of the staff of *Punch,* which had begun its career in July 1841. 'Miss Tickletoby's Lectures on English History,' with which his contributions practically began, naturally fell rather flat, but his copy improved, his sketches were generally appreciated and no one was more at home at the famous 'Punch' dinners, where the policy of the journal was shaped. His first great success was made with 'Jeames's Diary,' November 1845. This satire on railway-stock gambling was followed by the famous 'Snobs of England, by One of Themselves,' which began on 28 Feb. 1846 and ran for a year. Thackeray discovered snobs in altogether too many quarters, perhaps, and he has been accused of overlooking one at home; but it was only natural that he should work a good vein to the point of exhaustion and some of his papers were very clever. Most of them were reprinted as 'The Book of Snobs' in 1848. His next series, to-day more attractive to some readers, was his 'Prize Novelists,' excellent burlesques, which ran from April to October 1847, and took off, without malice and with very great cleverness, such popular writers as Bulwer, Disraeli, G. P. R. James, Lever and Cooper. One, 'Crinoline, by Je—mes Pl—sh, Esq.' was a takeoff of Thackeray himself. These were only the leading things he contributed to *Punch*. Probably they are not so attractive to many readers to-day as some of his ballads and songs — particularly such a perfect piece of occasional poetry as 'The Cane-Bottomed Chair.'

His increasing success enabled him in 1846 to take a house and bring his daughters back from Paris to a home of their own. In this house, 13 Young street, he wrote 'Vanity Fair,' which was published, as the fashion then was, in monthly parts. In January 1847, it began to appear in yellow-covered pamphlets issued by the publishers of *Punch*, and it ran till July 1848, when a double number was given. This method of publication was bad, because it did not force the author to complete his work and thus get the opportunity to see and criticize it as a whole before committing himself to type. It conduced also to spasmodic writing and to padding. Most of Thackeray's longer stories show the evil effects of the part system, and so do the novels of Dickens and Lever.

At first 'Vanity Fair' did not greatly attract the public, although now the opening chapters that introduce Becky Sharp are usually found very interesting. Contemporaries, of course, could have no idea that she was destined to become one of the great heroines of fiction, and they knew Thackeray, not as a distinguished novelist, but as a clever satirist and burlesquer and draftsman. Before 1848, however, readers were awake to the fact that they had another great novelist in their midst. Charlotte Brontë and the *Edinburgh Review* acclaimed him, and he became something of a literary lion. To this day 'Vanity Fair' is regarded by many people as his most important though not his most artistic work, and readers still divide into partisans of Dickens and of Thackeray, the latter usually winning the suffrages of the more critical.

Meanwhile Thackeray, again rivaling Dickens — the rivalry was of the friendliest kind save for one episode to be mentioned later — had published several Chrismas books: 'Mrs. Perkins's Ball' (December 1846) the success of which is said to have helped 'Vanity Fair,' 'Our Street' (1847), 'Dr. Birch and His Young Friends' (1848), 'Rebecca and Rowena' (1849), the clever but perhaps superfluous skit upon 'Ivanhoe,' and 'The Kickleburys on the Rhine' (1850), which was attacked in *The Times* and effectively defended in a preface to the second edition.

In November 1848 the first part of 'Pendennis' appeared. It was not concluded until December 1850, owing to a severe illness which Thackeray had in the autumn of 1849. It is the most autobiographical of his novels, and much ingenuity has been displayed in discovering the supposed originals of his characters. Maginn, for example, is thought to have been represented in Captain Shandon. It is more certain that 'Pendennis' is an effective presentation of literary life in London in Thackeray's day, and that he had no intention of running down his brother authors, as some critics accused him of doing. With all its merits 'Pendennis' suffers, as do 'Vanity Fair,' 'The Newcomes,' and 'The Virginians,' from its sprawling length.

Efforts had been made to supply Thackeray with a permanent, definite income by securing him an appointment as a magistrate or in the postal service; but his well-meaning friends had failed. In 1851, disliking the stand taken by *Punch* against Napoleon III, he resigned from the staff. Although he still continued to contribute, it seemed advisable to secure another source of income. This he found in lecturing. In May and June 1851 he delivered six lectures before distinguished audiences in Willis's Rooms, on his favorite humorists of the 18th century. They were successful when delivered, and, in their collected form (1853), rank high among his works, for their charm of style and their rare sympathy. They were subsequently delivered in other places in Great Britain, and then, on 30 Oct. 1852, Thackeray sailed (in company with A. H. Clough (q.v.) and James Russell Lowell) to deliver them in America.

Just as he was starting he received a copy of the novel he had been working upon for months, reading in the British Museum for materials and laboring carefully upon his style. 'The History of Henry Esmond, Esq.' was not published in parts, and hence is the most artistic of Thackeray's novels, with the exception of 'Barry Lyndon.' Its subtle study of feminine character, its nice balancing of romance and the realism that accompanies a minute knowledge of a period such as Thackeray possessed of the 18th century and particularly of the reign of Queen Anne, its attractive though perhaps somewhat over-labored style, and above all its pervading atmosphere of tender sentiment, have made it not only a classic historical romance but the favorite book of many Thackerayans, to whom it is idle to point out that perhaps the novel is after all masterly tour-de-force, that the essential vigor of Thackeray's genius is better displayed in the superb irony of 'Barry Lyndon' and in the unflinching portrayal of human vices and follies that makes 'Vanity Fair' memorable.

In America, Thackeray was most cordially received, and by his genial manners he won many friends. He lectured in the chief cities North and South and sailed for home in April 1853, much richer in purse (£2,500). Fortunately he did not attempt to turn his visit to greater account by writing a book upon it, as Dickens had done years before.

The next two years were spent in good part on the Continent. The idea of 'The Newcomes' came to him in Switzerland, and during a protracted stay in Rome, where he had a bad attack of fever, he wrote that charming burlesque for children 'The Rose and the Ring' (1854). The novel for older children, with its delightful old-child figure, Colonel Newcome, was published in monthly parts from October 1853 to August 1855 inclusive; and is said to have netted Thackeray £4,000. The spasmodic mode of composition affected the structure detrimentally, but Thackeray's satiric power and his increasing mellowness of sentiment were excellently blended, and the book may fairly be called a masterly presentation of domestic life. The character of Colonel Newcome, who has some of the traits of Thackeray's stepfather, is said by late critics to be grossly exaggerated. «Charmingly idealized» would seem a better phrase in view of the appeal the old man has made and still makes to thousands of hearts.

In October 1855 Thackeray again sailed to the United States, where he again remained until the following April, lecturing on 'The Four Georges' with great success and repeating with less 'The English Humorists.' In 1856 he delivered the 'Georges' throughout England and Scotland, and enjoyed the society of his children and his numerous friends, making other lives bright, although his own was somewhat clouded by the precarious state of his health. In July 1857 he stood as the Liberal candidate for Parliament from Oxford and was defeated by a small majority, accepting his disappointment gracefully. In November 1857 the quasi-sequel to 'Esmond,' for which he had gathered material in America, the only partially successful 'Virginians,' began to appear and ran its course in monthly numbers until October 1859. It was at least a notable link between the mother and the daughter country and, although it shows plainly the effects of Thackeray's increasing bodily sufferings, it probably deserves more praise than it usually receives.

At this time one of the most unpleasant incidents in Thackeray's life occurred. Edmund Yates (q.v.), a rising journalist, published in June 1858 a sketch of Thackeray that was not altogether pleasing to the latter. Thackeray replied in a stinging letter; Dickens was unfortunately drawn into the affair on Yates' side; Thackeray laid the correspondence before the committee of the Garrick Club; the committee and the club took it too seriously; and Yates, refusing to apologize, was dropped from the club. Dickens seems to have been in the right, Thackeray unintentionally in the wrong. Alienation between the two ensued; fortunately a few days before Thackeray's death, they met by accident and shook hands spontaneously.

In 1860 a long-cherished desire of Thackeray's was fulfilled. His publishers, Smith and Elder, began to issue *The Cornhill Magazine* in January, and made him editor. The first number had an enormous sale and he was as delighted as a boy. He secured Anthony Trollope and other good contributors, but for his own part was forced to content himself with printing 'The Adventures of Philip' instead of a great historical romance of the age of Henry V about which he had dreamed. Neither 'Philip' (1861, 1862) nor 'Lovel the Widower' (1860, 1861) was altogether worthy of his genius, but the delightful essays known as 'Roundabout Papers' (collected, 1863), and to a less extent 'The Four Georges' (not reprinted until they appeared in the Collected Works, 1867–69) surely were. Thackeray soon found the cares of editorship — especially the duty of refusing contributions even from a writer like Mrs. Browning, too onerous, and he was too old to become methodical; so he resigned in April 1862. His health steadily declined — though one finds little trace of the fact in the admirable chapters of 'Dennis Duval' (1867), which was running in *The Cornhill* at the time of his death. In November 1862 he was seriously ill. With his white hair he passed for an old man, although he was about 52½ years on that fatal night of 23 Dec. 1863, when he went early to bed without suspecting that death was so near. An effusion of blood took place in his brain, and he was found dead in the morning. On 30 Dec. 1863 he was buried simply at Kensal Green.

Thackeray, as has been said, was very tall — «a colossal infant,» Motley called him, with «white, shiny, ringletty hair . . . a roundish face» and «a little dab of a nose upon which it is a perpetual wonder how he keeps his spectacles.» He was as attractive to his friends as he still is to the admirers of his genius. Perhaps he was too much of a Bohemian in some respects, but as a father and a genial, kind-hearted man it would be hard to name his superior. As a man of letters his rank is, of course, very high. Besides being one of the chief of English novelists, he was a draftsman of ability, though not of genius, an excellent writer of society and satiric verse, an eminent lecturer, a charming letter writer, one of the best of the English essayists, a born provider of burlesques and comic skits for the public of his day — in brief, he was an author of varied and copious genius, a master of humor, of satire, and of sentiment, and in addition a critic of limited though by no means small intellectual powers and an admirable stylist. Unfortunately the task of appraising the value of his work has been rendered difficult by the extravagant worship of his partisans. Many of the volumes that have been added to his works since his death represent merely his talents as a journalist, not his genius as a writer, and even his best books are often defective in structure or in strength. We are still too near him to be able to tell whether he will finally outrank Dickens as a creative force in literature or whether he will rank with Fielding as a portrayer of characters and manners. We are not too near to perceive that he is not so important in the evolution of fiction or so cosmopolitan and heroic a figure as Sir Walter Scott. But his place is certainly with this small group of illustrious novelists. See BARRY LYNDON; HENRY ESMOND; NEWCOMES, THE; PENDENNIS; VANITY FAIR.

Bibliography.— Thackeray's works have appeared in many editions — notably that of 1883–84 in 26 volumes, and the 'Biographical Edition,' with valuable introductions of Mrs. Richmond Ritchie, 13 volumes, 1898–99. Quite a Thackeray revival occurred after the publication of Mrs. Ritchie's edition — editions being superintended by Mr. Lewis Melville (important for completeness, faithfulness to the older texts, and bibliographical information), by Mr. Walter Jerrold, and by W. P. Trent and J. B. Henneman (the Cornhill Edition, 1904, 30 vols., with introductions and bibliography). The chief lives of Thackeray are those by Anthony Trollope ('English Men of Letters,' 1879), by Herman Merivale and F. T. Marzials ('Great Writers,' 1891), by Lewis Melville (2 vols., 1899) and by Charles Whibley (1903). There are numerous volumes of Thackerayana and separate reprints of early works, as well as several special bibliographies, such as M. H. Spielmann's 'The Hitherto Unidentified Contributions of W. M. Thackeray to Punch' (1900). His correspondence with the Brookfields was collected in 1887. Consult also the article by Leslie Stephen in the 'Dictionary of National Biography,' and for criticism, W. C. Brownell's essay in 'Victorian Prose Masters' (New York 1901); Benjamin, L. S., 'Some Aspects of Thackeray' (Boston 1911).

William P. Trent,
Professor of English Literature, Columbia University.

THAI, an East Indian word meaning "free," and the general designation of certain peoples of Farther India, including the Thos, Muongs, Shans, Laotians and Siamese. Although widely diverging in certain characteristics, they speak languages derived from the same stock, and are evidently of common descent. The Siamese, the best known and most civilized of the Thai group, are considerably mixed with Malays, Hindus and other races, and are of medium stature and broad-headed. The Laotians are shorter in stature than the Siamese, and their skulls are less distinctly of the broad-headed type. Consult Diguet, 'Etude de la Langue Tai' (Paris 1896). See Laos; Shan States; Siam.

THAIS, thā'ĭs, a Greek hetæra: b. at Athens, who accompanied Alexander the Great on his expedition to Asia. She is said to have instigated Alexander to set fire to the citadel of Persepolis, the residence of the Persian kings, in revenge for the injuries done to her native city by Xerxes; but this anecdote, though immortalized by Dryden, is probably untrue, as we know on the authority of Arrian that it was his intention to sack the place and burn the citadel on grounds of state policy. After the death of Alexander, Thais became the mistress of Ptolemy Lagi, and, according to Athenæus, was afterward married to him. She was celebrated for wit and repartee, and many anecdotes are recorded of her talent.

THALBERG, täl'bĕrg, **Sigismund**, Swiss pianist: b. Geneva, 7 Jan. 1812; d. Naples, 27 April 1871. He was the natural son of Prince Moritz Dietrichstein and Baroness von Witzlar. He studied piano playing. At 14 was an accomplished player. In 1830 he made his first concert tour in Germany and in 1835–45 toured in Belgium, Holland, England, Russia and Spain, while in 1855–56 he visited South America and the United States. His playing was notable for its beauty of tone and the charm of its legato, rather than for brilliancy or fire. To him belong certain innovations in playing, accepted on account of his prominence though not original with him; such for instance as that of playing the cantilena in strongly accented notes by the thumbs, while the disengaged hand plays arpeggios or octave-passages above and below the melody. His operas, 'Florinda' (1851) and 'Cristina di Suezia' (1855) were both failures. He composed many piano pieces, including fantasies on themes from various operas. His 'Studies' for the pianoforte are highly valued by teachers.

THALENITE, a native yttrium silicate, having the formula $H_2Y_4Si_4O_{15}$, recently discovered in Österby, Sweden. It occurs in tabular, monoclinic crystals of a flesh-red color; hardness 6.5; specific gravity 4.23.

THALER, tä'lėr. See Dollar.

THALES, thā'lēz, Greek philosopher: b. Miletus, Asia Minor, about 625 to 640; d. about 543 B.C. He was the earliest philosopher of Greece, and founder of the Ionian school. He traveled in Crete, Phœnicia and Egypt, where he calculated the heights of the pyramids, and received instructions from the priests. From them he probably acquired a knowledge of geometry, in which he excelled his teachers. He is the father of abstract geometry, being the first to demonstrate that a circle is bisected by its diameter; that the angles at the base of an isosceles triangle are equal; that two straight lines cutting each other produce opposite and equal angles; that the angle of a semi-circle is a right angle, etc. After his return from Egypt he was reckoned among the seven wise men, and his sayings such as γνῶθι σεαυτόν ("know thyself") were in the highest repute among the ancients. To the Ionians he gave the wise counsel to form a general confederacy for the purpose of resisting the Persian power, and to make Teos the seat of the union. He also dissuaded the Milesians from entering into an alliance with Crœsus against Cyrus. His philosophical doctrines were preserved only by oral tradition, until Aristotle committed them to writing several hundred years after his death. He considered water the element of all things. His most important pupils were Anaximander, Anaximenes and Pherecydes. Consult Allman, G. J., 'Greek Geometry from Thales to Euclid' (1877); Diels, H., 'Parmenides Lehrgedicht' (Berlin 1897).

THALIA, thă-lī'ạ, "the blooming one," one of the nine Muses. She was the Muse of comedy and pastoral poetry, and is usually represented with the comic mask and the shepherd's crook in her hand. One of the Graces was also called Thalia. See Graces.

THALLIUM, a metallic element discovered by Sir William Crookes (1862) in a deposit obtained from the lead chambers of a sulphuric acid works at Tilkerrode in the Harz. On examining this deposit with the spectroscope the discoverer observed a single sharp and brilliant green line, which was afterward shown to be characteristic of this element. Crookes gave the element the name of thallium from the Greek *thallus*, a green twig. Thallium is found in many natural sulphides such as those of iron, copper, zinc, bismuth, etc. An important mineral containing it is Crookesite, a compound of sulphur, copper, silver and thallium. When iron or zinc sulphide is burned in the process of making sulphuric acid, the thallium burns to its oxide which collects in the flues or in the lead chambers. To obtain metallic thallium from this flue dust, it is dissolved in dilute sulphuric acid, filtered, and hydrochloric acid added. The slightly soluble thallium chloride separates. This is changed to the sulphate, purified at the various elements accompanying thallium and the thallium sulphate decomposed by electrolysis or by action of zinc. Thallium, symbol Tl, has an atomic weight of 204.18, specific gravity 11.19 and fuses at 561° F. A freshly cut surface has a brilliant silver white lustre which is quickly lost by the oxidizing action of the air. It is softer than lead and is malleable. The metal dissolves readily in sulphuric or nitric acids, but only slightly in hydrochloric acid. It forms two classes of compounds: the thallous compounds derived from the oxide Tl_2O, and the thallic compounds from Tl_2O_3. The salts of the first class resemble the corresponding salts of potassium and sodium. The chloride, however, resembles those of silver and lead in its insolubility in water. Thallium compounds give a green color to a non-luminous name. They are very poisonous, resembling lead in physiological action. Thallium and its compounds are used in the manufacture of thallium glass, the high refractive power of which makes it valuable in the preparation of optical instruments and of artificial gems.

THALLOPHYTA. See BOTANY; PALEOBOTANY.

THALWEG, the lowest line of any valley or drainage course. In valleys with rivers, it is the actual stream course, in dry valleys it is the gully through which storm waters run off.

THAMES, tĕmz, Canada, a river in the southwestern part of Ontario, rising in Perth County, and flowing southwest, 160 miles, into Lake Saint Clair, about 30 miles east of Detroit, Mich. It is navigable, 18 miles to Chatham, by boats of considerable size, but has a difficult bar at the mouth. On the banks of this river, about 30 miles above Chatham, a final stand was made by General Proctor and Tecumseh, when pursued by General Harrison in the War of 1812. The position chosen was poor and very favorable to the American advance. On 5 Oct. 1813 Harrison with 3,000 men attacked and by a vigorous charge of cavalry under Colonel Johnson drove the British in great confusion from the field. Tecumseh was slain and General Proctor himself barely escaped capture. The Americans lost 47 and the British 48, besides 33 Indians; 477 prisoners were captured. The results of the battle were: the Indian Northwestern Confederacy was destroyed; the British power in Upper Canada was broken and practically all that had been lost by the Americans at Detroit was regained.

THAMES, thāmz, Conn., a river in the southeastern part of the State, formed by the junction of the Quinebaug, Shetucket and Yantic rivers at Norwich, whence it flows south about 15 miles to the Long Island Sound. Near its mouth on the right bank lies the city of New London. It is really a tidal estuary, a wide and beautiful waterway navigable for large vessels to its head, and an important avenue of local commerce.

THAMES, tĕmz, England, the most important and famous river in Great Britain, rising in Gloucestershire, and flowing in an irregular eastward course into the North Sea. It separates the counties of Gloucester, Oxford, Buckingham, Middlesex and Essex on the north from Wilts, Berks, Surrey and Kent on the south. Its total length, measured from the Nore Light, is 217 miles, of which 180 miles are navigable. The upper waters around Oxford are known to the poets as Isis. The river passes the cities of Oxford, Reading, Maidenhead, Windsor, Chertsey, Kingston, and passes through the heart of London. Below London it widens gradually into an estuary, which, at the mouth, is 27 miles wide. The river is navigable for the largest vessels up to the east end of London, where the great Victoria, Albert and West India docks have been constructed. The upper course is connected by an extensive canal system with the Severn River and the middle counties. Pike, perch; roach, dace and other fish are caught in quantities. The surface of the Thames from Oxford is largely taken up by pleasure craft on holidays in fine weather, and the regattas held then are world famous. The Medway is the largest tributary. The Cherwell flows in at historic Oxford 112 miles up stream; the Pang flows in at Pangbourne 51 miles from the mouth, and the Kennet at Reading, six miles farther down. The water supply of London is taken mainly from the Thames. The natural flow is about 350,000,000 gallons a day, and the water companies take about 130,000,000 of this. Naturally the utmost care is taken to preserve the water from pollution by sewage. In passing through London the water front of the river is vastly increased by the method of constructing docks cut out in rectangles from the land. In no other way could the 40 miles of water front be made to serve the enormous business of London.

THAMES, Battle of the, in the War of 1812. On 12 Sept. 1813 General Harrison, who was still at Seneca on the Sandusky River (see FRENCHTOWN, BATTLE OF), received word of Perry's victory on Lake Erie (see ERIE, LAKE, BATTLE OF; PERRY, O. H.) and began to prepare for his campaign against Detroit. By dint of hard work Harrison recruited his army to 6,500 troops, commanded by Brig.-Gens. Duncan McArthur and Lewis Cass, Lieut.-Col. James V. Ball, Gov. Isaac Shelby of Kentucky and Col. Richard M. Johnson (qq.v.). At Malden and Detroit Proctor had 983 British regulars and at Amherstburg were 3,500 Indians, but when Harrison landed at Middle Sister Island, Proctor burned the public property at Detroit, and on 24 September withdrew to Sandwich. Three days later Harrison occupied Malden, then entered Sandwich, Proctor having evacuated, and began energetically to pursue the retreating British, who on 5 October made a stand on the Thames River, a mile from the Moravian town and about 30 miles above Chatham. The British formed with their left near the road to Detroit, and their reserve with a six pounder between the road and the river, while the Indians were on the right near a swamp. Harrison divided his troops as follows: Gen. George Trotter's brigade of 500 men in front, with right on the road and left on the swamp; Gen. John E. King's brigade 150 yards to the rear; and still further in the rear David Chile's brigade as reserve, the whole under Maj.-Gen. William Henry. *En potence* on Trotter's left were Gen. Joseph Desha's three brigades, facing the Indians in the swamp. In front, directly facing the British, was R. M. Johnson's mounted regiment. Johnson divided his regiment, sending half under his brother, James, to take the cannon. So impetuous was the charge that James' cavalry broke through the first British line and penetrated to the rear of the second, almost capturing Proctor and taking many prisoners. R. M. Johnson meanwhile crossed to attack the Indians but owing to the underbrush was forced to dismount his men. He drove the Indians toward Shelby's Kentuckians who poured such a terrific fire into them that, after Tecumseh had fallen, they gave way on all sides and were pursued a considerable distance. This ended the battle. The Americans loss was 17 killed and 30 wounded; the British lost 48 killed and wounded and 33 Indians, besides 477 prisoners. Proctor's shattered army fled 100 miles to Ancaster where on 17 October the fugitives were stopped. This destroyed the Northwestern Indian Confederacy; broke the British power in Upper Canada; regained for the Americans all they had previously lost at Detroit, and enabled Harrison to reinforce the army at Buffalo, then preparing to invade Canada from that point. (See York; Fort George; Stony Creek; Chrystler's Farm, etc.). Harrison returned to Detroit and later Cass was appointed by the President governor of Michigan Territory. Consult Wiley and Rines, 'The United States' (Vol. V, pp. 398–401); Adams, Henry, 'Administrations of Jefferson and Madison' (Vol. VII, pp. 128–143); Young, Bennett H., 'Battle of the Thames,' in 'Fison Club Publications,' No. XVIII; 'American State Papers, Military Affairs' (Vol. I); Montgomery, Henry, 'Life of Harrison'; histories of the war by McAfee, Breckenridge, Richardson, Lossing, Ingersoll; Dawson, 'Battles of the United States'; Armstrong, John, 'Notices'; Brown, S. R., 'Campaigns'; McMullen, 'History of Canada'; Slocum, 'The Ohio Country'; Brannan, 'Official Letters'; Fay, 'Official Accounts'; biographies of Cass, by Hickman, Smith and McLaughlin.

THANATOPSIS («a view of death»), the earliest American poem to present a thoroughly noble thought in a thoroughly noble form, was written by William Cullen Bryant — then about 16 — in 1810, published, without the poet's knowledge, in the *North American Review* in 1817 and greatly revised for Bryant's 'Poems' of 1821. From the first it was regarded as a masterpiece, and it speedily won a hold upon the popular mind which has hardly been surpassed by that of any other serious native poem. Without question, the large, simple idea of the piece has had much to do with its fame. There is consolation for most human beings in the reflection that death, though unavoidable, is also common to all, and that the whole of mankind shall eventually lie in the splendid earth. Perhaps Bryant's answer to the question which had been tormenting him — How can one be reconciled with death? — is more stoical, more pantheistic, than many of his readers have suspected: he offers no promise of immortality and refers to no deity higher than nature. But the sincerity and eloquence of 'Thanatopsis' lift it above argument. Its language is pellucid and harmonious, its diction full of felicity, its images — especially those derived from American landscape — magnificently outlined, its blank verse stately, its rhythms in close accompaniment with its swelling emotions. It is the distilled essence of late Puritanism, preoccupied still, as the Puritans had been, with the thought of death, and yet so far freed from their particular doctrines and biases as to be able to utter a universal thought in universal terms.

Carl Van Doren.

THANE, the name of an ancient rank among the English or Anglo-Saxons. A freeman not noble was raised to the rank of a thane by acquiring a certain portion of land (five hides for a lesser thane), by making three voyages at sea or by receiving holy orders. Offices, whether connected with the constant personal service of the king or only during his residence in the thane's district or with the administration of justice, were entrusted only to the thane, whose landed property was a guarantee for his conduct. The Anglo-Saxon thanes were the predecessors of the Norman barons.

THANKSGIVING DAY, in the United States, an annual festival of thanksgiving for the mercies of the closing year. The day is fixed by proclamation of the President and the governors of States. The President's proclamation makes the day a legal holiday in the District of Columbia and in the Territories. In 1789 the Episcopal Church formally recognized the civil government's authority to appoint such a feast and in 1888 the Roman Catholic Church also decided to honor a festival which had long been nearly universally observed — though nowhere with such zest as in the New England States, where it ranks as the great annual family festival, taking the place which in England is accorded to Christmas. The earliest harvest thanksgiving in America was kept by the Pilgrim Fathers at Plymouth in 1621 and was repeated often during that and the ensuing century; Congress recommended days of thanksgiving annually during the Revolution and in 1784 for the return of peace — as did President Madison in 1815. Washington appointed such a day in 1789 after the adoption of the Constitution and in 1795 for the general benefits and welfare of the nation. Since 1863 the Presidents have always issued proclamations appointing the last Thursday in November as Thanksgiving Day.

THAPSIA, a genus of umbelliferous plants, either perennial or biennial. The decompound leaves are doubly or trebly pinnatifid, the flowers are small, yellow, white and purple, in many-rayed compound umbels, without involucre, and often without the small-bracted involucels. The most important *Thapsia* is the deadly carrot (*T. garganica*), supposed to have been the source of the gummy accretion called «asadulcis» by the ancients and esteemed by them as a drug. A resin is obtained by evaporating the tincture, and the amber-colored resin produced in Algeria is called bon-nafa. Thapsia was formerly employed as an acrid counter-irritant in plasters, for rheumatic and similar pains. *T. decipiens* is the black parsley of Maderia, with a thick umbrella, or palm-like, crown of finely-cut foliage three or four feet across.

THASO, thā'sō, or **THASOS**, an island at the northern end of the Ægean Sea, off the coast of Macedonia. Its area is 167 square miles. It is nearly round and about 16 miles in diameter. Excepting some low strips along the shore adapted to agriculture, it is covered by thickly wooded mountains, which in ancient times yielded gold and marble. The forests contain wool valuable for shipbuilding. Corn, fruit, oil and wine are produced; wax, honey and a superior marble are exported. It was settled by the Greeks about 700 B.C. About 463 the Athenians captured the city, razed the walls and took away the shipping. The Romans freed the territory after the battle of Cynoscephalæ, 197 B.C. The Phœnicians were attracted to the island at an early epoch by the gold-mines; and an Ionic colony settled there in 8 A.D. The island since then has changed hands several times and now has an Egyptian ruler. The capital, ruins of which are still to be seen, was on the northern coast, on the site of the present landing-place of Limena. The population is distributed mainly through 10 villages and totals about 12,000.

THATCHER, thăch'ėr, **Henry Knox**, American naval officer: b. Thomaston, Me., 26 May 1806; d. Boston, Mass., 5 April 1880. In 1823 he entered the navy as midshipman and became a lieutenant 1833. In both attacks on Fort Fisher in 1862 he commanded the first division of Commodore Porter's fleet. After the Civil War he commanded the Gulf squadron until 1866 and the squadron of the Pacific from 1866–68. He was made rear-admiral in 1866 and was retired 1868.

THAUN, or **THAON**, **Philippe de**, early Anglo-Norman poet: b. probably near Caen, France, about 1100. He wrote a versified ecclesiastical calendar known as 'Li Cumpoz' and his is the earliest work of this period (about 1115) that is known. His most important work was written about 10 years later and is known as 'Li Bestiare' or 'Physiologus.' This also was in rhyme and but one copy is known. In it the creatures are grouped and treated symbolically. The manuscript was dedicated to Adelaide, queen of Henry I, and the work is valued chiefly as a linguistic relic. Consult Walberg's 'La Bestiare de Philippe de Thaün' (Paris 1900).

THAW CASE, a criminal trial noted in legal annals as «the most notorious case in the recent history of American criminal law.» Harry Kendall Thaw, son of a distinguished and wealthy Pittsburgh, Pa., family, 25 June 1906, shot and killed Stanford White, a distinguished architect, in the roof garden of Madison Square Theatre, New York. The murder was the outcome of Thaw's marriage to Evelyn Nesbit, an artist's model and actress, who accused White of abusing her. A long-drawn-out trial resulted, notable for Thaw's plea of insanity, his escape from Matteawan State Hospital for the Insane, his flight into Canada, his ejectment from the country and subsequent arrest in New Hampshire and repeated trials following. In the original trial Thaw was sent to Matteawan, 1 Feb. 1908, and was kept there until 17 Aug. 1913, when he escaped by alleged conspiracy with his keepers. After a long legal battle, in which noted lawyers were concerned, Thaw finally was brought back to New York State, indicted for conspiracy and acquitted. Later he was declared sane and taken to his Pennsylvania home where he remained because of the refusal of the local authorities to agree to his extradition.

THAXTER, thăks'tėr, **Celia Laighton**, American poet: b. Portsmouth, N. H., 29 June 1835; d. island of Appledore, Isles of Shoals, 26 Aug. 1894. She spent her childhood and much of her later life at the Isles of Shoals. In 1851 she was married to Levi Lincoln Thaxter, who was accustomed to visit the island long before they had become a popular summer resort. Her first published poem, 'Landlocked,' was printed by Lowell in the *Atlantic*. The motive of subsequent verse is also generally the sea and coast scenery, though the arts, particularly music, claimed some of her attention. Its note is one of much original power. Her works are 'Poems' (1872); 'Among the Isles of Shoals,' prose sketches (1873); 'Poems' (1874); 'Drift Weed' (1879); 'Poems for Children' (1884); 'The Cruise of the Mystery' (1886); 'Idyls and Pastorals' (1886); 'The Yule Log' (1889); 'An Island Garden,' a prose diary (1894); 'Letters' (1895); 'Stories and Poems for Children' (1895). A collected edition of the 'Poems' appeared in 1896. Consult the 'Letters'; also an article in the *New England Magazine* (Vol. 24, pp. 166–72).

THAXTER, **Roland**, American botanist: b. Newton, Mass., 28 Aug. 1858. After receiving a Harvard education and securing his Ph.D. there, in 1888 he became a professor of biology and botany in the university and a noted authority on the fungous diseases of animals and on cryptogamic botany. From 1885 to 1891 he was expert mycologist of the Connecticut Agricultural Experiment Station. He was chosen American editor of the British 'Annals of Botany'; elected president of the American Botanical Society and in 1912 made a member of the National Academy of Science. He has contributed to many scientific publications dealing with his specialties.

THAYER, thăr, **Abbott Handerson**, American figure painter, who also has painted animals and landscapes: b. Boston, 12 Aug. 1849. He was a student at the École des Beaux Arts under Lehman and Gérôme from 1875 to 1879. Upon his return to America he was made president of the Society of American Artists. He was the discoverer in 1894 of the Laws which underlie Concealing Coloration; and published in 1909 'Concealing Coloration in the Animal Kingdom' (written by his son, Gerald H. Thayer). He is a member of the National Academy of design, of the American Academy of Arts and Letters and of the L' Insigne Reale Accademia Romana delle Belle Arti Denominata di San Luca. Among his popular works are 'A Young Woman' (in the Metropolitan Museum, New York); 'A Virgin' (National Gallery, Washington, D. C.); 'Winged Figure' (Albright Gallery, Buffalo); and 'Caritas' (in the Boston Museum).

THAYER, **Alexander Wheelock**, American biographer: b. South Natick, Mass., 22 Oct.

1817; d. Trieste, Austria, 15 July 1897. He was graduated from Harvard in 1843 and from the Law School in 1848. For a time he was assistant in the Harvard Library, and while there determined to write a life of Beethoven. In 1849 he went to Europe to collect material for this work and lived abroad the greater part of his life. In 1859–82 he was United States consul at Trieste, Austria, and after that devoted himself entirely to his literary work. The first volume of his 'Life of Beethoven' appeared in 1866; the second in 1872; the third in 1879 and the fourth was nearly completed at the time of his death; it was published in German, although originally written in English. It deals with the life and character of the man Beethoven rather than with his musical work; and is very detailed, exact and impartial. Thayer also wrote 'Signor Masoni' (1862), and 'The Hebrews and the Red Sea' (1883).

THAYER, Benjamin Bowditch, American mining engineer: b. San Francisco, Cal., 20 Oct. 1862. He was educated in the Harvard Scientific School and on graduating in 1885 at once began active work in connection with the Anaconda Copper Company, of which he became president. He later was made vice-president of the Amalgamated Company which absorbed it. He was president of the American Institute of Mining Engineers in 1914 and the following year was named on the United States Naval Consulting Board, where he did much good work.

THAYER, Eli, American educator and inventor: b. Mendon, Mass., 11 June 1819; d. Worcester, Mass., 15 April 1899. He was graduated from Brown University in 1845; became principal of the Worcester Academy; and in 1848 founded The Oread, an institute for young ladies in Worcester. He was a member of the State legislature, 1853–54, and of Congress, 1856–61, and conducted an «Emigrant Aid Company» which settled portions of Kansas on the anti-slavery basis. Subsequently he acquired manufacturing interests in Massachusetts and received patents for a section safety steam boiler, a boiler-cleaner and a hydraulic elevator. Besides his Congressional speeches (1860), he published a volume of 'Lectures' (1886), and 'The History of the Kansas Crusade' (1889).

THAYER, Ezra Ripley, American advocate and educator: b. Milton, Mass., 21 Feb. 1886; d. September 1915. He took his LL.B. degree at Harvard in 1891 and was admitted to the bar in Boston directly afterward. His progress was rapid and he became Dane professor of law at the university and dean of the Law School. He was a member of a noted firm of attorneys and was particularly interested in raising the standards of his profession.

THAYER, James Bradley, American author and lawyer: b. Haverhill, Mass., 15 Jan. 1831; d. Cambridge, Mass., 14 Feb. 1902. He was educated in local schools and graduated at Harvard in 1852. He devoted his life to teaching but after securing his LL.B. degree from the university in 1856 rose speedily in the law, to which he was admitted in that year. In 1873–93 he was Royall professor in Harvard and from 1893 to 1902 held the chair of World professor. Iowa University gave him its LL.D. degree in 1891; Harvard in 1901. In 1861–65 he was secretary of the Loyal Publication Society, and was also fellow of the American Academy of Arts and Sciences and a member of the Massachusetts Historical Society. Besides many contributions to scientific publications he was author of 'Letters of Chauncey Wright' (1877); 'A Western Journey with Emerson' (1884); 'Cases on Evidence' (1892); 'The Origin and Scope of the American Doctrine in Constitutional Law' (1893); 'The Teaching of English Law in Universities' (1895); 'Cases in Constitutional Law' (2 vols., 1895); 'The Development of Trial by Jury' (1896); 'Preliminary Treatise on Evidence at the Common Law' (1898), etc.

THAYER, John Adams, American publisher: b. Boston, 20 Feb. 1861. He had a common school education in Cambridge and became a noted printer and typefounder. In various responsible capacities he was connected with such representative publications as the *Ladies' Home Journal, Munsey's Magazine,* the *Delineator,* etc. After a residence in Paris from 1906 to 1911 he again became a publisher, notably to the *Smart Set Magazine.* His best known publication is 'A Publisher's Life Story' (1910; rev. ed., 1912).

THAYER, John Milton, American soldier, lawyer and politician: b. Bellingham, Mass., 24 Jan. 1820; d. 1906. He graduated at Brown University in 1841 and became a member of the Massachusetts bar, removing in 1854 to Nebraska where he was made a member of the territorial legislature in 1860. Previous to entering on political life he was a territorial brigadier-general and fought successful Indian campaigns, placing the Pawnees on a reservation in 1859. In the Civil War he also was a brigadier-general and led a Nebraska regiment. For services at Vicksburg, he was brevetted major-general. Returning to Nebraska in 1865 he was elected to the United States Senate (1867) and afterward was appointed by Grant as governor of Wyoming Territory. In 1866 he was elected governor of Nebraska and also was made department commander of the G. A. R. for his State. Brown University conferred on him the honorary A.M. degree in 1847 and the University of Nebraska gave him its LL.D. in 1902.

THAYER, Joseph Henry, American educator: b. Boston, Mass., 7 Nov. 1828; d. Cambridge, Mass., 26 Nov. 1901. He was graduated from Harvard in 1850, from Andover Theological Seminary in 1857, and was pastor of the Congregational Church at Salem, Mass., in 1859–64, being absent from his charge for nine months in 1862 when he served as a chaplain in the Union army. In 1864 he accepted the chair of sacred literature at Andover, which he resigned in 1882 to become professor of New Testament criticism at Harvard. He published 'A Greek-English Lexicon of the New Testament' (1869); 'A Biographical Sketch of Ezra Abbot' (1884); 'The Change of Attitude Toward the Bible' (1891); 'Books and Their Use' (1893); etc.

THAYER, Sylvanus, American soldier: b. Braintree, Mass., 9 June 1785; d. South Braintree, 7 Sept. 1872. He was graduated at Dartmouth in 1807, and at West Point in

1808. For four years he was occupied, chiefly around Boston and New York, in the construction of coast-defenses. During the War of 1812 he served as chief engineer of the Northern army on the Niagara frontier and at Lake Champlain, and as chief engineer and brigade-major in the defense of Norfolk, Va. After a tour of observation in Europe, where he studied fortifications and military schools, he became superintendent at West Point, a position which he held from 1819 to 1833. He was made president of the board of engineers, and placed in charge of the construction of defenses and harbor improvements around Boston. Upon these duties he was occupied during the remainder of his active service. He was retired 1 June 1863, having been commissioned colonel in the preceding March. He gave funds for a public library and an academy in his native town, and for founding the Thayer School of Civil Engineering at Dartmouth. In 1877 his remains were taken from South Braintree, where they were first buried, and interred at West Point, where in 1833 a statue was erected in his honor, bearing an inscription in which he is called the «Father of the United States Military Academy.»

THAYER (WHITNEY), Eugene, American organist and composer: b. Mendon, Mass., 11 Dec. 1838; d. Burlington, Vt., 27 June 1888. He was for nearly 20 years a resident in Boston, where in April 1869 he gave the first free organ recital in the United States, and removing to New York in 1881 became organist of the Fifth Avenue Presbyterian Church. Besides a 'Festival Cantata' he composed a mass in E flat, many organ pieces and much vocal music. He received the degree of doctor of music from Oxford.

THAYER, William Makepeace, American Congregationalist author: b. Franklin, Mass., 23 Feb. 1820; d. Franklin, 7 April 1898. He was graduated from Brown University in 1843, and was pastor of the Congregational Church in Ashland, Mass., from 1849 until 1857, at which date he resigned and devoted himself to writing. He was a member of the State assembly 1857–58 and 1863–64, and engaged in editorial work 1858–72. His publications, very popular in their day and chiefly for juvenile reading, include 'The Bobbin Boy' (1859); 'Youth's History of the Rebellion' (1863–65); 'Men Who Win' and 'Women Who Win' (1869); 'From Log Cabin to White House'; 'From Tannery to the White House' (1885).

THAYER, William Roscoe, American author: b. Boston, 16 Jan. 1859. He was graduated from Harvard in 1881; was assistant editor of the Philadelphia *Evening Bulletin* 1882–85; and was editor of the *Harvard Graduates Magazine* 1892–1915. He has published 'Confessions of Hermes' (1884); 'Hesper' (1888); 'The Dawn of Italian Independence' (1893); 'Poems: New and Old' (1894); 'Throne Makers' (1899); 'History and Customs of Harvard University' (1898); 'A Short History of Venice' (1903); 'The Life and Times of Cavour' (2 vols., 1911); 'The Life and Letters of John Hay' (2 vols., 1915); 'Germany versus Civilization' (1916); 'Letters of John Holmes' (1917); 'Out of Their Own Mouths' (1917); 'Collapse of Superman' (1917); 'Theodore Roosevelt' (1919). He is an overseer of Harvard College; vice-president American Historical Association; member National Institute of Arts and Letters; Fellow, American Academy of Arts and Letters; Fellow, American Academy of Arts and Sciences, and corresponding secretary, Massachusetts Historical Society.

THAYER, William Sydney, American physician: b. Milton, Mass., 23 June 1864. He was graduated at Harvard in 1885 and took his degree as doctor of medicine there in 1889. He was for some time a member of the medical staff of the Johns Hopkins University and visiting physician at the hospital there. He is a member of several medical societies at home and abroad, and has made valuable researches in fevers and was first to report the third heart sound at his clinics. In 1917–18 he was with the Russian mission to Petrograd. He is the author of several medical and surgical works, notably 'Lectures on Malarial Fever' (1897).

THAYER SCHOOL OF CIVIL ENGINEERING, a department of Dartmouth College (q.v.).

THEAGENES (thē-ăj'ĕ-nēz) **AND CHARICLEA,** kăr-ĭ-klē'ą, a Greek romance written by Heliodorus, bishop of Trikka, in the 4th century. The story recounts the love and adventures of Theagenes, a Thessalian and Chariclea, daughter of the queen of Ethiopia, and is the foundation of many later romances both by the early Greek fablers and the later French novelists, including Achilles Tatius among the former, and Gomberville, Scudéry and D'Urfe among the latter. It was translated into English by Thomas Underdown (1577), and into French by Jacques Amyot (1586).

THEATINES. See ORDERS, RELIGIOUS.

THEATRE (Greek, «a place for seeing,» from θεᾶσθαι, to regard or look at), literally any building used for purposes of exhibition, but now generally applied to a place in which dramatic and musical performances are given. The theatre may be considered as a form of architecture which found its earliest expression in the classic ages of Greece and Rome, and after a long eclipse has again become important within the last 250 years. The term theatre also comprises the whole mass of dramatic literature and its theatrical representation. In this article it is proposed to deal (1) with the theatre as an architectural edifice from its earliest beginnings down to the present. For the treatment of the theatre as a form of artistic expression see DRAMA.

The Theatre in Architecture.— The theatre had its origin among the Greeks. Its germ was the ring in which dithyrambs and phallic songs were performed by choruses in honor of Dionysus. These were performed in an orchestra or circular dancing place, on all sides of which the spectators were ranged. Later a table was introduced, on which the leader of the chorus stood while he carried on a dialogue with the rest of the *choreutæ* in the intervals between the choral odes. This table was the first and most rudimentary form of stage and the date of its introduction is about 560 B.C. Next an actor, a single actor, was introduced by Thespis and, as he played many different parts, a tent had to be erected in which he should be able to change his mask and dress. Out of this tent arose ultimately the stage buildings of the Greeks, which, even after they became elaborate structures of stone, retained the name *skēnē*, "tent or booth" (cf. English *scene*).

Greek Theatrical Architecture.— From the remains of various Greek theatres which have been excavated it is possible to reconstruct, at least in its main features, one of these edifices. In the centre the orchestra formed an exact circle in the middle of which stood the altar of Dionysus. Later the circle was cut on the side next the stage. Round the orchestra, in size rather more than a semi-circle, the seats for the audience rose tier upon tier like a modern baseball field-stand. These seats were at first of wood, but owing to a collapse of the benches in 499 B.C., it was resolved at Athens to erect a permanent stone theatre. This was the theatre of Dionysus, which exists to-day, although it has been partly reconstructed. It consists of three parts — the orchestra, stage buildings and the auditorium. The orchestra was occupied solely by the chorus. Behind it rose the stage buildings, usually a long, narrow rectangle, facing the audience; the most ancient one at Athens was 55 yards long and only 11 yards deep. But then little scenery was used. In front the buildings represented a palace or a temple. There were usually three doors opening on to the stage, which was a wooden platform, standing 8 or 10 feet above the orchestra. On it the actors appeared. The auditorium was of great extent as the theatre was intended to accommodate practically the whole population of the city in which it stood. The rows of seats in consequence were of enormous size, the theatre of Dionysus at Athens holding 27,500 persons, and that at Megalopolis being computed to seat 44,000. In order to obtain the necessary slope for the tiers of seats as well as a natural substructure for the same the Greeks always chose some natural hollow, where the shape of the ground aided the design of the architect. Tiers of seats rose one above another, divided vertically by passages for access and in many cases horizontally also. The lowest or first row of seats at Athens is of marble, and was reserved for persons of distinction; the rest are of ordinary stone. Between the auditorium and the stage were the passages of entrance (*parodoi*) which in some instances were of great breadth. The back-wall was called the *scena*, the side-walls, or wings, in each of which was an entrance door being called *paraskēnia*. The stage was called the *proscenium*. A flight of steps, later two, connected the stage with the orchestra and these steps, continued out of sight beneath the orchestra floor, were the means by which apparitions from the lower world ascended. The front of the stage nearest the orchestra was called the λογεῖον (*logeum*). The back-wall represented a suitable background or setting for the play, and, before the performance, was covered by a curtain (*aulaia*) which was let down, not drawn up as is usual to-day. When the action of the play required a different scene, the back of the stage was covered with painted curtains or boards. At either end of the stage were large revolving triangular prisms, each side of which bore a different scene, thus providing three sets of wings. In dealing with the early Greek theatre it must always be remembered that the stage was only of secondary importance, the orchestra being deemed the chief point of interest. There was a certain amount of machinery, of which the most famous was a species of crane by which a god could be let down from on high or drawn up again as occasion required. The Greek theatre was open to the sky and attendance at it was a species of religious observance; performances took place only on festal days, when the whole population turned out to witness them. The acoustic properties appear to have received little attention. Actors used a species of megaphone device, concealed in their masks, in order to make their voices carry to a distance. Besides the theatre at Athens Greek theatres existed also at Epidaurus, Delphi, Syracuse and Megalopolis.

Roman Theatres.— The Roman theatre was largely founded on Greek models. It was long before a permanent theatre was erected in Rome because it was thought that such a costly display was not in harmony with the simplicity of the republic. At an early period dramatic performances took place in temporary wooden structures and amid such surroundings the comedies of Plautus and Terence were first produced. Toward the close of the republic vast wooden theatres were erected in Rome. Pompey was the first to construct one of stone. His theatre, which may be taken as the Roman model, near the Campus Martius differs structurally from the Greek model. The orchestra was a semi-circle and there was no altar. Singing and dancing were transferred to the stage and the orchestra space was occupied by seats for prominent persons. The stage was enlarged. The seats were built of masonry, not excavated out of a hill side or planted on a natural slope. The use of the arch and of concrete by the Romans facilitated this mode of building and under Roman hands the theatre first became an architectural unit, with auditorium, stage and stage buildings, all joined in a single structure. There are extensive remains of Roman theatres; among the most celebrated are those of Rome, Orange, France, Ephesus, Miletus, Cnidus, Tauromenium and Nimes. Roman theatres were frequently much smaller than the Greek and there were frequently arrangements to protect the audience from the sun's rays by an awning.

The Roman theatre of the empire period degenerated into sheer lasciviousness and the rise of Christianity brought a new and redoubtable foe to this kind of spectacle. The Fathers inveighed against the public spectacles and clerics were forbidden to be present. Thus gradually the new morality gained headway and the theatre ceased to be a feature of the social life of the people.

Middle Ages.— During this period the drama existed only in the form of mysteries and miracle plays and was under the management of the Church. Theatres were not required. Plays were presented generally in cathedrals or monasteries, and the most elaborate scenery used was a three-story scaffold representing heaven, earth and hell. Strolling players also gave performances in temporary booths. This period is, therefore, entirely barren as regards theatrical architecture.

From the Renaissance to the Present.—With the revival of learning in the 16th century came also a revival of the drama, and theatres began to be built. The earliest was probably a playhouse of some sort in the Hôtel de Bourgogne, Paris, which was built about 1548 for the Confraternity of the Passion; but the first regular theatre was that which Bramante constructed at Rome in the Grand Court of the Vatican about 1580. Then came the Teatro Olimpico at Vicenza, designed by Palladio, and finished in 1584; while the earliest theatre built on modern lines was constructed by Aleotti at Parma in 1618. In all the early Continental theatres, the construction was founded on Greek models, but in England a simpler idea served. Here the earliest dramatic performances took place in booths, tennis-courts or in the open courtyards of inns; and it was not till the end of the 16th century that the first permanent building was erected for theatrical purposes. This was «The Theatre,» built by Burbage in Shoreditch in 1576, which was founded not on any classical model, but on the innyards, in which the actors had been accustomed to play. The stage was literally a stage — a platform erected against one side of the building — and on three sides of this platform the spectators stood or sat in the pit (then called the yard), while all round it ran the galleries or boxes (then called rooms) exactly like the galleries of an innyard. There was no provision for scenery. The door at the back of the stage, which communicated with the dressing-rooms, etc., and was the general entrance for the actors, was hung with curtains, and there seem to have been curtains running on rods, some distance up the stage which could be drawn and undrawn to indicate an inner apartment, but the locality in which the scene was laid was indicated only by a placard stuck up bearing such an inscription as «A garden,» «This is a forest,» etc. Properties, or furniture were, however, largely used to give verisimilitude to the action. These properties seem to have been pushed on the stage in the calmest fashion. Thus in Middleton's 'Chaste Maid in Cheapside,' one stage direction runs, «A bed is thrust out upon the stage, Alwit's wife in it,» and a similar action is indicated in the stage-direction, «Enter Anne in bed,» in Davenport's 'New Trick to Cheat the Devil.' In the stage there were traps apparently to a considerable extent; while behind and on a higher level was a platform which did duty for any elevated part of the supposed scene. In the Elizabethan theatre the stage was strewed with rushes, or, upon very special occasions, was matted; and on it the young «bucks» or gallants sat on stools, showing their dress and figure to the audience, and effectually destroying anything resembling dramatic illusion. After the Restoration, under Charles II, who was familiar with the French stage, the English theatre came more into line with the Continental. The stage was gradually withdrawn closer and closer to the proscenium opening, until, by 1750, the appearance of the interior of Drury Lane was not seriously different from that of to-day. Movable scenery, which was invented by Baldassare Peruzzi early in the 16th century, had long been used in masques, but it was not till 1661 that it was used to illustrate a regular stage-play in England. Meanwhile theatrical architecture was developing on the Continent along classic lines.

The first theatre in America was opened at Williamsburg, Va., 5 Sept. 1752. Others followed at Annapolis, Md., and in Nassau street, New York, in 1753, Albany, 1769, Baltimore, 1773, Charleston, S. C., 1774, Newbern, N. C., 1778, and Boston, 1792. Modern theatres are comparatively small because it has been found that the voice cannot be distinctly heard without straining more than 90 feet in front of the speaker. Little change was made in theatrical architecture during the 19th century. In the latter half of the century sumptuous houses were erected on the Continent and in England and America, of which the most celebrated was the Paris Grand Opera. Notwithstanding the vast size of the building, the auditorium contains only 2,194 seats. By far the greater part of the building is occupied by a vast number of rooms, halls, staircases, shops, etc., appurtenances designed for the convenience and pleasure of the spectators and of those connected with the theatre. In magnificence and costliness the Paris Grand Opera was easily the first theatre of the 19th century. In the opening decades of the 20th century several monumental playhouses were erected in England, and in the United States; of these one of the most remarkable if not the most beautiful in design and appointments is the Century Theatre, New York. In this century also playhouses began to be constructed once more as isolated buildings in which exterior design played a large part. The interior arrangements of modern American theatres are superior in comfort and convenience to those of Europe, although the latter are often lavishly decorated. In America, seating, heating, ventilation, exits and fireproof construction receive the most careful attention. The largest theatre in America is the New York Hippodrome, which seats over 5,000 and is used for spectacular entertainments. The modern theatre contains like its prototypes the two essentials of auditorium and the stage. To the auditorium are now appended corridors, foyers, lounging-rooms, etc., also an outer lobby, vestibule and approaches. The auditorium is generally of the horseshoe type, but in many recent constructions the rows of seats on the ground floor and balcony are kept straight. A special development is the modern opera-house with as many as five balconies and a large number of boxes. In the modern playhouse there are few boxes; the ground floor has a steep pitch so that the spectators in each row may view the stage clearly over the heads of those in the row in front. The first balcony is more steeply pitched than the ground floor, and the second and succeeding balconies still more. Lavish decoration after the Italian and French models is giving way to straight lines and bare walls with a simple color scheme. The acoustic problem is one of the most serious with which the architect of theatres has to deal. The stage is now the most elaborate part of the theatre. The opening on the auditorium is from 25 to 35 or 40 feet wide and from 14 to 22 feet high. The stage is frequently twice the height of the proscenium so that all scenery («drops,» etc.) may be hung above the proscenium opening when not in use. The set-scene is now in very general use and to a great extent eliminates the necessity for a high stage. The set-scene is built so solidly and reproduces the conditions of nature with such completeness as scarcely to make any demands on the imaginative faculty of the spectators. If a room is represented, the walls and ceiling are built with marvelous solidity, a chandelier hangs from the centre of the ceiling; the doors shut with an unmistakable bang; the windows open and close better than they sometimes do in actual life. In elaborate plays whole pieces of scenery are raised through large transverse openings in the stage by means of platforms called *bridges*. These work in and out of the *well* or cellar, a space under the stage nearly as deep as the proscenium opening is high. Above the stages are the *flies*, larger lateral galleries, in which the scene-men («fly-men») work their ropes and pulleys. Higher still is the *Grid-iron*, an open line of strong beams from which various borders or drops are hung. Above this is the barrel-loft or rigging-loft, in which are the drums, pulleys or windlasses by which the curtains and clothes are worked. With the extensive use of elaborate scenes and the demand for rapid shifting there has been developed the revolving stage, which is a circular platform about 40 feet in diameter and revolving on a shaft embedded in concrete. This circular platform is capable of holding about four sets which can be brought before the audience by revolving the platform. The sliding stage is one of double width and which is moved laterally so that on the concealed half the following scene may be set up while the play proceeds on the exposed half.

Perhaps the greatest change in the modern as compared with the older theatres is in the lighting arrangement due to the introduction of electricity. The lights in the trough below are called footlights, those above border lights. There are sets of bulbs in white and in two or more colors. Dimmers are used to lower the intensity of the bulbs. All lights (except perhaps the spotlights) are now controlled from a single switchboard at the side of the stage. Recently several open-air theatres have been constructed in America. Some of these are of the ancient type, as that at Berkeley, Cal., while others are of the so-called garden type in which the landscape architect plays a leading rôle. There is a good example of the garden type at Vassar College. Among recent innovations in theatrical structure are the little theatres, some of which seat only 100, and the portmanteau theatre, an approach to the mediæval traveling theatre, but more artistic and better adapted to the present-day intimate form of drama.

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THEATRE, The American. In order to convey to the reader a fair understanding of the progress of the American theatre since 1795 it is perhaps necessary to state something about its beginnings, which, indeed, previous to 1750, are involved in much obscurity. Tony Aston, an English stroller of some celebrity, visited the Southern and Middle colonies about 1730, and gave entertainments at New York and perhaps other places; and there is some evidence that a company of comedians acted plays in New York in 1732; but it was not until 1749 that an organization came into existence of which we can form any definite judgment. This company attempted to open a playhouse in Philadelphia, and Addison's 'Cato' was actually performed; but the performers were arrested and admonished by Recorder Allen to give up the undertaking. Thomas Kean was the principal actor in both tragedy and comedy, and one Murray seems to have been associated with him in the management. Finding Philadelphia too inhospitable, the players went to New York, where they were advertised as the company of comedians from Philadelphia, and gave the first theatrical season of which we have any connected account. The performances were given in a «convenient room» in a house belonging to Rip Van Dam in Nassau street, and extended over a period of more than a year — from 5 March 1750 to 8 July 1751. The first play was 'Richard III,' in which Kean played Richard. So far as is known, the company appeared in 15 plays and nine farces. Although Mr. Kean formally announced his withdrawal from the stage to resume his business of writing, he was with a company called the «Virginian Comedians» at Annapolis in the summer of 1752, when Lewis Hallam and his London players arrived at Williamsburg, Va. Besides Mr. Kean there were other members of the New York company among these «Virginia Comedians.» Perhaps this disposes of the claim usually made for Hallam's company as being the first regular theatrical organization in America.

Lewis Hallam, who brought a company of comedians from London in 1752, was not an actor of any consequence in England, nor is it likely that his wife, known to the American stage successively as Mrs. Hallam and Mrs. Douglass, was an actress of recognized ability there.

The Hallam company reached Yorktown in June 1752, and began playing at Williamsburg on 5 September following, the opening pieces being 'The Merchant of Venice' and 'Lethe.' The only other play the Hallam company is known to have performed at Williamsburg was 'Othello,' 9 Nov. 1752. From Williamsburg Hallam went to New York, where he arrived in June 1753, and played until the following March. Mrs. Hallam played the leading parts in both tragedy and comedy, while her daughter, Miss Hallam, was put forward in farces. Hallam seldom appeared. The great Shakespeare rôles were divided between Malone and Rigby, the former playing Shylock and Lear, and the latter Richard and Romeo. From New York the company went to Philadelphia, where the engagement was limited to 25 performances. This ended the theatrical campaign of Lewis Hallam the elder, who retired with his family to Jamaica, where he died soon afterward.

A year or two after Mr. Hallam's death his widow married David Douglass, who organized a theatrical company in Jamaica in 1758 for another American campaign, with Mrs. Douglass as his chief attraction. Besides his mother, young Lewis Hallam was the only member of Mr. Douglass' company who had previously appeared in the New York and Philadelphia theatres. He had already become a full-fledged tragedian, although he was only in his 20th year, sharing the leading parts in tragedy and comedy with Mr. Harman, as Rigby had previously shared them with Malone. Mrs. Harman, who was a daughter of Charlotte Charke and a granddaughter of Colley Cibber, was also with the company, and next in consequence to Mrs. Douglass. The low comedian was Owen Morris, who was identified with the American theatre for a full half century — 1759–1809. After his arrival in New York, Douglass had much difficulty in obtaining permission to open the theatre that he had built on what was called Cruger's Wharf, and it was not until 28 Dec. 1758 that he began a brief season with the tragedy of 'Jane Shore.'

During the following spring and summer Mr. Douglass built a theatre at Vernon and Smith streets in Philadelphia, which he opened 25 June 1759, and maintained with considerable regularity until the close of the year. He had obtained authority to act from Governor Denny, and the compact was kept, although the opposition to the theatre was so great in the province that an act prohibiting plays was passed by the assembly to go into effect 1 Jan. 1760. After Philadelphia was closed against him, Mr. Douglass went to Annapolis, where he played an engagement. The company also performed in other Maryland towns, and at Newport and Providence in 1761. In the autumn Mr. Douglass built another theatre in New York, in what was then Chapel (now Beekman) street, where he gave performances from 19 Nov. 1761 to 26 April 1762. This ended his first attempt to achieve the mastery of the colonial stage. In his few years of management Douglass had become an actor of considerable authority, attempting such parts as Sir John Falstaff in 'King Henry IV' and Mercutio in 'Romeo and Juliet.' In the latter young Hallam played the lover to his mother's Juliet. In the last New York engagement, Mrs. Hallam, the wife of the youthful tragedian, was seen in a few parts, but the pair separated soon afterward.

It has always been understood that after his retirement from New York in 1762 Mr. Douglass did not venture upon the continent again until 1766, when he built the Southwark Theatre in Philadelphia. On the contrary, he appeared in Charleston in November 1765 and remained there until the following April. Lewis Hallam was not with the company, and, with the exception of Mrs. Douglass and Miss Hallam, the performers were all new to the stage. Only three of the new players were still with Douglass when he reached Philadelphia — Messrs. Woolls and Wall and Miss Wainwright. With the opening of the new theatre in Southwark, Philadelphia, began the theatrical organization afterward known as the "Old American Company." Lewis Hallam was once more in the lead. Mr. Morris and Mrs. Harman were again with the company. During this season a so-called comic opera, 'The Disappointment,' said to have been written by Col. Thomas Forrest, afterward a distinguished officer in the Revolutionary army, was announced for production, but it was withdrawn because it contained "local reflections." As a recompense for its withdrawal, 'The Prince of Parthia,' by Thomas Godfrey, Jr., was produced 24 April 1767. This was the first tragedy written and played in America. The season was noteworthy for the first appearance in America of John Henry, who was the partner of Lewis Hallam after the Revolution in the management of the Old American Company.

While the company was playing in Philadelphia, Mr. Douglass built a new theatre in John street, New York, which was the second of the permanent theatres in the colonies, the Southwark being the first. The first season at the John street house lasted from 7 Dec. 1767 to 2 July 1768. The company alternated between these two theatres down to the time of the Revolution; but Mr. Douglass found the patronage of the two cities inadequate as early as 1770–71. In the latter year he made a tour to the southward as far as Williamsburg, Va., playing at Fredericksburg, Suffolk and other towns, and building a theatre at Annapolis, where the company played an engagement in the autumn of 1771. In 1773 Douglass also built a theatre at Charleston, S. C., which was the last of the many buildings he erected for theatrical purposes. The company played at Charleston from 22 Dec. 1773 to 19 May 1774. In October following the Continental Congress passed a resolution forbidding theatrical performances, in view of the impending Revolution, and the organization was disbanded. Hallam went to England, where he appealed to the London public at Covent Garden Theatre as Hamlet in 1775. His mother, Mrs. Douglass, died in Philadelphia at the close of 1774, and Mr. Douglass returned to Jamaica, where he became a magistrate.

It is an interesting fact, showing the theatrical activity before the Revolution, that while the American Company was acting in New York and Philadelphia in 1766–69 there was a company in the South giving performances at Annapolis and Williamsburg. This company was known as the "Virginia Comedians" in 1768, when it gave a long season at the Virginia capital; but it assumed the name of the "New American Company" when it was at Annapolis from January to June 1769. The leading spirits of the Virginia Comedians were Messrs. Verling and Bromadge, and Mrs. Osborne, who had played with Douglass at Charleston in 1765–66, and Mr. Godwin, who was with the American Company at the Southwark in Philadelphia in 1766–67. All these were with the New American Company, with the exception of Mr. Bromadge. A number of bills of the Virginia Comedians at Williamsburg in 1768 have been preserved.

The most important annals relating to the American stage that have escaped the destroying hand of time are a collection of playbills made by Thomas Llewellyn Lechmere Wall — Mr. Wall of Douglass' company. These cover 40 years of the theatrical life of the actor and are especially valuable for the complete information they afford in regard to the Baltimore Company, organized by Wall and Lindsay in 1782. Wall was perhaps the only member of the American Company who remained behind when Douglass returned to Jamaica in 1774. He was also the only manager who undertook to produce plays before the close of the Revolution. In 1781 he was at Annapolis giving entertainments with the assistance of his wife and daughter when the French army was on the march to Yorktown. For one of his performances at that time he succeeded in securing the services of the band belonging to the regiment of Count de Chaleur. Later in the year he went to Baltimore, where he repeated his Annapolis entertainments, and in conjunction with Adam Lindsay, a tavern-keeper at Fell's Point, built a theatre, of which Lindsay and Wall were the nominal managers, with Wall as the stage director. The company was formed on what was afterward known as the «commonwealth plan.» The theatre was opened 15 Jan. 1782 and continued open without important interruptions until 9 July — 42 nights. In all 19 plays and 14 farces were produced, and the total receipts for the season were $14,209, an average of $338.50 per night. With the exception of the Walls the players were all new to the American stage, and, it may be assumed, were all amateurs.

The second season at the Baltimore theatre extended to 7 Feb. 1783. On the third night of the season at Baltimore, Mr. and Mrs. Dennis Ryan appeared in 'Douglass.' Ryan dominated the company from the outset, and when Wall retired from the management, 7 Feb. 1783, he assumed the reins, keeping the theatre open from 11 February to 9 June. From Baltimore Ryan carried his company to New York and opened the theatre in John street. Wall was with Ryan's company, which remained until the British evacuation, giving two performances in October 1783, while the military players gave a performance for Mrs. Ryan's benefit. In the winter Ryan again opened the Baltimore theatre, the season extending from 7 Dec. 1783 to 14 Feb. 1784. The only noteworthy event of this season was the first production of the 'School for Scandal' in America, 3 Feb. 1784, with Mrs. Ryan as Lady Teazle. After the close of the Baltimore season in 1784, Ryan took the company to Richmond, where he played a long engagement. Mr. Heard, who was the original Sir Peter Teazle in this country, joined the forces of Hallam and Henry, while other members of the organization found professional employment in the South during the rest of the century.

After the Revolution both Lewis Hallam and John Henry sought to control the theatres that had been built by Douglass; but Hallam was the first to present a company of comedians to the New York public, opening the John Street Theatre 24 Aug. 1785. Hallam proposed a partnership with Henry, and the firm of Hallam and Henry, which ruled the American stage during the next seven years, came into existence. The John Street Theatre reopened under their management 21 Nov. 1785. Henry engaged in England a number of capable actors and actresses whose names are part of the history of the American stage, while Wignell not only succeeded in building in Philadelphia the first really handsome and complete theatre in the United States, but put into it the best company of players that had as yet been tempted to cross the Atlantic.

An incident of the Hallam and Henry partnership, previous to the reorganization of the company, that needs to be noted here is the production of the first American comedy, 'The Contrast,' by Royall Tyler. This piece, which was first produced in New York 18 April 1787, was written for Wignell, who wished to play a Yankee character. Wignell's Jonathan deserves remembrance as the forerunner of the long series of stage Yankees that afterward became popular with American audiences. The comedy was printed in Philadelphia, and was often played by strolling companies before the close of the century.

The only really important recruits engaged by Mr. Henry in England were Mr. and Mrs. Hodgkinson, of the Bath and Bristol theatres, and Mrs. Wrighten, who had long been a favorite singer and actress at Drury Lane. Hodgkinson was a man of great talent and versatility, and the best actor seen in America up to that time and for many years afterward. He made his début as Don Felix in 'The Wonder,' at Philadelphia, 26 Sept. 1792, succeeded Henry as one of the managers of the Old American Company in 1794, and was active as actor and manager in New York until after the opening season at the New Theatre in 1798. Mrs. Hodgkinson, known at Bath and Bristol as Miss Brett, was an actress of merit, and in this country eclipsed both Mrs. Henry and Mrs. Hallam, the wives of the managers by whom the Hodgkinsons were engaged. Mrs. Wrighten was known in America as Mrs. Pownall. She died at Charleston in 1796, after introducing her two daughters to the stage in this country. One of them, Caroline, married Alexander Placide, who had been a rope dancer in England. She was the mother of the famous Placide family of actors. It was during this period that William Dunlap became prominent as a dramatist and adapter of plays. His first comedy, 'The Father,' was produced at the old John Street Theatre, 7 Sept. 1789. Dunlap became associated with Hallam and Hodgkinson in the management of the New York company in 1796, and he was afterward for a brief period the sole manager of the New Theatre, better known as the Park.

After leaving the Old American Company, in the beginning of 1792, Thomas Wignell associated himself with A. Reinagle, a musician who came to American in 1786, in the project of building the New Theatre in Philadelphia, afterward known as the Chestnut Street Theatre. The house was modeled after the theatre at Bath, and was completed early in 1793; but owing to the yellow-fever epidemic it was not opened by the company of players engaged by Wignell until 17 Feb. 1794. Among the actors and actresses comprising the Philadelphia company were Mr. Fennell, a young tragedian of much promise; Mr. and Mrs. Whitlock, the latter a sister of Mrs. Siddons; and Miss George, who was the wife of Sir John Oldmixon, and was known to our stage as Mrs. Oldmixon. This company remained intact without any important changes or additions for three years, playing alternately in Philadelphia and Baltimore; but in the autumn of 1796 Mr. Wignell brought three important recruits from England — Mrs. Merry, the famous Miss Brunton of Covent Garden Theatre, who had become the wife of Robert Merry, the Della Cruscan poet; Thomas Althorpe Cooper, then a young man of 20 but destined to be the manager of the New York theatre for many years; and William Warren, who had been a strolling player in England, and who became the successor of Wignell in the management of the Philadelphia theatre. Mrs. Merry became a widow in 1798. She soon afterward married Wignell, and after his death she became the wife of Warren, who survived her many years.

A fortnight before the formal opening of the Philadelphia theatre by Wignell's company a new theatre in Boston, scarcely inferior to the Philadelphia house, was opened by an English company engaged and brought over by Charles Powell. This theatre was in Federal street and was built by subscription. It was destroyed by fire in 1798. Powell's company was a feeble one, and he closed his second season in 1795. Powell was succeeded by Col. John S. Tyler, a brother of Royall Tyler, the author of 'The Contrast,' who managed the house on behalf of the stockholders from January to May 1796. The season proved a failure; but the theatre was reopened in September by John Brown Williamson, an English actor, whose wife was popular in London as Miss Fontenelle; but neither he nor his wife nor a stronger company than had as yet been seen in Boston availed to make the season successful. One reason for this was that a new theatre, known as the Haymarket, had been built through the exertions of Charles Powell, and opened by him for the first time 26 Dec. 1796. Among Powell's English recruits for the Boston Haymarket were Mr. and Mrs. Giles L. Barrett, the parents of the famous New York comedian, George H. Barrett; Mr. and Mrs. Simpson, afterward New York favorites; and Mrs. Simpson's three daughters, the Misses Westray, of whom Juliana became Mrs. William B. Wood; Eliza, successively, Mrs. Villiers and Mrs. Twaits; and Ellen, Mrs. Darley. Powell again failed at the Haymarket, and the house passed into the control of Hodgkinson, Hallam and Dunlap, under the personal direction of Hodgkinson. The New York company occupied it in the summer of 1797, after which it was abandoned. The Haymarket deserves to be remembered for the production of two American war plays — 'Bunker Hill,' by John Daly Burke, 20 Feb. 1797; and 'West Point Preserved,' the first of the André pieces, by William Brown, on 17 April following. Dunlap's 'André' was not produced in New York until 30 March 1798. This epoch, 1792–98, was also remarkable for theatrical activity in the South. Not only had the Baltimore company, including Mr. and Mrs. Ryan and Mr. Wall, played a long engagement at Richmond as early as 1784, but in 1790 John Bignall and Thomas Ward West were the managers of a company called the "Virginia Comedians." This organization maintained its existence for many years, its circuit extending from Richmond and Norfolk to Charleston. Bignall, who was held by his Southern admirers to be the best actor on the continent, died in 1794. His real name was Moneypenny, and he had been a stroller in England in the same company with William Warren, of the Philadelphia theatre. After Bignall's death West became the sole manager of the company and piloted it over the Southern circuit for a number of years. In 1795 there was a rival theatre in Charleston, conducted by Mr. Jones, who had been previously at the Boston Theatre. His principal actress was Mrs. Whitlock, who had just retired from the Philadelphia company. A Frenchman, M. Sollee, succeeded to the management of this theatre, and organized a company in Boston to play in Charleston for the season of 1795–96. Mr. and Mrs. Whitlock, Mr. and Mrs. Placide and Mrs. Arnold — afterward Mrs. Poe and the mother of Edgar Allan Poe — were in the company.

The prosperity which had given to America three splendid theatres within five years — the Chestnut Street in Philadelphia, the Park in New York, and the Boston Theatre in Federal street, Boston, rebuilt immediately after its destruction in 1798 — was followed by a period of depression that was severely felt over all the country. At the close of the century Wignell was in jail for debts incurred through the Philadelphia theatre, and Dunlap, who had undertaken the sole management of the New York theatre to retrieve previous losses in New York and New England, lost his entire private fortune in the venture. Mr. Barrett was induced to undertake the management of the new Boston Theatre in 1799, but he failed dismally.

In all these cities theatrical enterprises were experimental for several years, but in every case a manager was finally found in the local company who succeeded in placing the theatre on a sound business and artistic basis. Mr. Warren, after he became Wignell's successor in Philadelphia, associated with himself in the direction of the Chestnut Street Theatre a popular young member of the company, William Burke Wood. This partnership lasted until 1825. In New York the young tragedian Cooper retrieved the fortunes of the Park Theatre and made the house a paying one for a number of years. In Boston, Snelling Powell, a brother of Charles Powell, secured control after other attempts had failed, including the assumption of the management of the Boston Theatre by Charles Whitlock in 1800. John Bernard, an English actor of some repute who joined the Philadelphia company in 1797, was for a while Snelling Powell's associate in directing the Federal Street Theatre; but for many years Powell's partner was Mr. Dickenson, who was an actor of moderate ability, but a man of sound judgment and an excellent manager. These were the dominating theatres in the United States during the first quarter of the century, and their influence in giving tone and character to theatrical enterprises in the country was felt down to 1850.

The Old American Company was designed to be permanent in organization, but all the early managers, from Douglass to Wignell and Hodgkinson, aimed at controlling a circuit of playhouses modeled after the provincial circuits in England. The building of the new theatres in Philadelphia, New York and Boston resulted in giving companies that were permanent in organization permanence of home. These were the real stock-company days, but a tendency toward the star system was manifested almost from the outset. In 1796 Mrs. Whitlock played what was essentially a star engagement at the Boston Theatre; it was limited to 12 nights, for which she was paid $450 and allowed a benefit. Hodgkinson played star engagements in all the leading cities between 1798 and 1805, and Cooper followed Hodgkinson's example, and was a star from youth to old age. But the first star to shine with extraordinary effulgence in the American theatrical firmament was George Frederick Cooke. He was the first English actor of great reputation who came to America to play the leading rôles of tragedy and comedy with the stock companies in the principal cities. In view of this the star system, as it ruled in the American theatres for the next half century, may be said to date from his appearance here in 1810–11.

Simultaneously with Cooke's performances in the theatres of Philadelphia, New York and Boston were the star engagements of John Howard Payne. Cooke played three engagements in Philadelphia — in all 39 nights. His highest receipts for any one night were $1,475, his lowest $474. His average for his last Philadelphia engagement of 12 nights in 1811 was $807.50. Payne played to an average about the same time of $442, while Cooper's Philadelphia average was $509. Young Payne's popularity rapidly diminished, and in 1812 he performed to receipts that fell as low as $255. After Cooke the next English star to appear in America was Holman, in 1812; but he came at a time of serious depression in consequence of the war with Great Britain, and the impression that he made fell far below his expectations. Then came Incledon and Phillips as musical stars, and after them the Wallacks, Henry and James W., and finally, to close the first decade of the star system in America, 1810–20, Edmund Kean. The great English stars who came to this country during the next three decades were Junius Brutus Booth and William Charles Macready, 1820–30; Fanny Kemble and her father, Charles Kemble, and Charles Kean, 1830–40; and Tyrone Power, James R. Anderson and Macready, again in the fullness of his fame, 1840–50. This long period had developed only two American stars of surpassing brilliancy — Edwin Forrest and Charlotte Cushman.

The century opened with about half a score of theatres in the leading American cities, only three of which, as already described, were worthy of the name or of the drama. Between 1800 and 1850 about 20 theatres were built in New York, none of them superior to the Park, and only one, the Bowery, in any sense its rival, until Burton established himself in Chambers street in the last decade of the epoch. The only new theatres of importance in Philadelphia during the same period were the Walnut Street and the Arch Street theatres, the former erected for a circus in 1808 and fitted up for theatrical uses in 1820, and the latter built in 1826. The theatres built in Boston in these 50 years were the Tremont, the American Amphitheatre,— afterward the Warren and National—Kimball's Museum, the Eagle and the Howard Athenæum. Baltimore had nothing better than the old Holliday Street Theatre during this epoch, and Washington was without a place of amusement worthy of the drama until 1835. The theatre builder of the period in the South and Southwest was James H. Caldwell. He built the American Theatre in New Orleans in 1823, and afterward erected the Camp Street and Charles Street theatres. Mr. Caldwell also built theatres in Cincinnati, Saint Louis, Natchez, Huntsville, Nashville and Petersburg. Another manager, John S. Potter, was concerned in building as many, or more, theatres in the South and Southwest; but, after all, the theatrical activity of a century resulted in an approximate number of theatres in actual use at its close not exceeding 50.

The figures that show the periods of prosperity and the intervening periods of depression are not easily obtainable, those that are in existence being widely scattered through books and newspapers or in private hands. The losses were sometimes heavy even in the early enterprises. The Philadelphia company in 1797 played 14 weeks in New York with a loss of $2,350; but, on the other hand, Caldwell, in 1818, cleared $10,000 in four months in Petersburg, Va. The receipts of the Park Theatre, New York, for the season of 1832–33 reached nearly $150,000, Fanny Kemble and her father drawing $56,000 for 60 nights, an average of $933 per night. In 1833–34, when the receipts at the Park fell to $135,000 for the season, the Kembles averaged $732 per night; but in 1834–35, without the Kembles, the season's total was over $160,000. At this time the star system was at its height of favor, with both managers and the public; but its effects were disastrous in cities where there were rival theatres outbidding one another for the best stars. This was especially true of the managers of the three rival theatres in Philadelphia who for nearly 20 years continued to cut one another's throats for the benefit of stars of no great magnitude. Wood, in his 'Recollections,' cites an example of the effects of the system. One of Fanny Ellsler's engagements in Philadelphia yielded $10,869.25, out of which the *danseuse* received $6,436. The money paid to the other dancers, the ballet and for the ordinary expenses of the house brought the expenditures up to $11,826, involving a loss to the manager of $1,000 for 10 nights. This system finally culminated about 1846, when nearly all the theatres in the country were ruined. But it was divided patronage as well as the excessive percentages of the stars that made the theatres in Philadelphia, New York and Boston unprofitable; for in the South, where Caldwell had a monopoly in his own field from Richmond to New Orleans the profits were very large, notwithstanding the frequent engagement of stars like Cooper, Booth and Forrest. This contrast receives additional emphasis from the fact that Caldwell was the only manager produced by the first century of the American theatre who died rich.

The closing years of the 19th century witnessed a partial revival of the old stock companies in their purity and simplicity, without the intervention of great stars, and it has also witnessed the nearly complete abolition of this form of theatrical organization. In the theatres managed by William Wheatley, John S. Clarke, and, for a time, by Mrs. John Drew in Philadelphia, by James H. Wallack in New York, and by Moses Kimball in Boston, stock companies were maintained. Later on, Lester Wallack, Augustin Daly, M. H. Mallory, Daniel Frohman, Charles Frohman and A. M. Palmer in New York, and R. M. Field in Boston, kept together for years organizations which were managed upon the pure stock system. Throughout the country generally the theatres for a while employed stock companies, but mainly for the purpose of supporting traveling stars. This continued until after the close of the Civil War, when the impetus given to business enterprises of all kinds was felt in renewed theatrical activity not only in the cities, but all over the country. What is known as the combination system (that is, a traveling company made up of a star and a supporting company), which began about 1869 and reached its highest development before 1876, involving the destruction of the stock companies in all except a few theatres, was the consequence of this theatrical revival. Nearly every inland town and city from Maine to California built a theatre, with the expectation that traveling companies would occupy it at intervals. The demand thus created could be supplied only by the combinations.

One of the first results of this new state of things was the banishment from the managerial office of all, or nearly all, the actor-managers. Their places were filled by business men, who, while they may have lowered, in a sense, the artistic character of the theatre, have raised its financial standing to a point which, during the first century of its existence, seemed beyond its reach. The theatre in America was no longer a haphazard thing, living from day to day on uncertainty. It became a business conducted on the principles which govern other forms of commercial enterprise, and is as stable, as sound and as certain of adequate rewards as any. Indeed, so abnormal has been the development of the business character of the theatre that it has excluded from general managerial attainments everything else. Very few of the managers throughout the country ever undertake the original production of plays, or take the trouble to acquire the artistic knowledge requisite for this kind of work. New York chiefly, and in a lesser degree Chicago and Boston, are the play-producing centres. A few New York managers and the play-producing stars select and bring forth all the plays and gather together all the companies which, supplemented by the imported attractions, keep the theatres of the country supplied with entertainment during the season. The advantage of this system is that playgoers everywhere are furnished with well-trained and perfectly equipped companies, appearing in plays which have been tried and found to be worthy. The local manager, free from the worries and cares incident to stage-work, devotes his time and attention to the comfort of his patrons at the front of the house, and to the strict conduct of business there. The results are well-regulated and comfortable auditoriums and good order in all the business departments of the theatre.

A remarkable aspect of the American theatre, from a commercial point of view, is the enormous profit it has yielded and continues to yield to home and foreign celebrities. Among American actors, Edwin Forrest acquired and left behind him a great estate, from the remnant of which was established the Forrest Home, near Philadelphia, a retreat for aged actors, noble in its purpose and efficient in its benefaction; Charlotte Cushman, resting for long periods in England and Italy, left a fortune of $600,000; Edwin Booth, having made and lost more than one competency, renewed his financial successes in his declining years, and left $750,000 to his heirs, after having founded the Players' Club at a cost of $200,000; Mary Anderson retired from the stage after a few seasons of brilliant and uninterrupted triumph, to enjoy a happy marriage in her youth, her labors having brought her a fortune of $500,000; Joseph Jefferson, blessed with that continuous vitality often found among the children of the stage, had in 1902 acquired a fortune of $1,000,000. Among foreign actors, William C. Macready owed to America the realization of his dream of retirement from a profession he affected to loathe; Sarah Bernhardt acquired here a fortune which enabled her to defy the authority of the house of Molière and to establish a theatre of her own in beautiful Paris; Tommaso Salvini, adding his great earnings here to his modest ones in other lands, became the richest actor Italy has ever known; and Henry Irving has found in his frequent visits to our country a public eager and willing to fill his coffers to overflowing with the rewards so justly due to his unequaled managerial achievements and to his undoubted genius as an actor. In the moving picture field Charlie Chaplin passed everybody else, and his income is stated to be fully $1,000,000 annually. The list of the well-rewarded favorites of the public might be greatly extended, but this glimpse of results is sufficient to make clear the profits and prosperity of the American stage, and to indicate the extent of its commercial advancement during the century.

The development of the theatre in all its departments, especially since 1860, has been vast. From not more than 100 in 1800, and fewer than 800 in 1860, the number of actors and actresses in the United States increased so immensely that in 1888 it was estimated at 4,500, and now probably exceeds 10,000. This number represents only the performers engaged in presenting the drama in its higher forms. It does not include the managers, who number several hundred, as compared with 25 or 30 in 1850 and six or eight in 1800. If the exponents of variety and vaudeville and the other employees in the amusement business are added, the number of people who gain a livelihood by giving public entertainments will not fall below 30,000; including stage hands and all the persons who derive their support from the theatre, the number may be roughly estimated at 100,000. This vast army of workers is well organized, generally well paid and reasonably prosperous. It has numerous charitable and social organizations, which are models of their kind. The Actors' Fund, the Actors' Order of Friendship, the Players' Club, the Green Room Club, the Lambs' Club, the Professional Women's League, are institutions of which any profession might well be proud; and there are numberless others of equal merit supported by the amusement makers of the United States. There are about 1,000 regularly organized theatrical companies on tour through the United States during the season, and the number of theatres of all kinds is 10,000.

In New York City there were in 1918, the following theatres: in Manhattan borough, about 50 theatres worthy of the name, the largest being the Hippodrome (seating 5,000), followed by the Manhattan Opera House (3,500), Metropolitan Opera House (3,366) and Century (2,890); and about 50 vaudeville and motion picture houses of the best class, the larger ones being the old Academy of Music (3,400), Strand (3,300), Audubon (2,653) and Lexington (2,559). In Brooklyn borough there are about a score of good theatres and some 30 first-class vaudeville and motion picture houses, the largest being the Halsey, Keeney, Ridgewood and Prospect, each of them seating 2,500. There are perhaps a thousand other minor theatres and picture houses.

The improvement which has taken place in the construction of theatres in America within the past 35 years is worthy of especial notice. The tragic disaster in Brooklyn on the night of 5 Dec. 1876 awakened the attention of managers and of the public authorities in the different States to the flimsiness of construction which marked even the best theatres of the period. The result was the passage of new and most stringent laws, involving requirements which, while they seemed onerous, perhaps, have resulted in giving to America the best and safest theatres in the world. Even the older theatres, built before the new regulations, have been so altered under the direction of the authorities that they are now comparatively free from danger. In New York, where these regulations are perhaps the strictest, there is a larger number of absolutely safe theatres than in any city in the world; while for beauty and convenience combined with safety it is impossible to find elsewhere such theatres as the Century, Strand, Gaiety, New Amsterdam, Victoria, New York, Knickerbocker, Empire, American and Metropolitan Opera House. As the older houses pass away they are replaced by absolutely fireproof structures if replaced at all.

Perhaps the most marked change that has taken place in the American theatre during the last hundred years is in the character and number of its patrons. Attendance upon the theatre was looked upon even 60 years ago by at least seven-tenths of the people of the United States as almost a sin. The fashionable ungodly and the lowest and most depraved made up the audiences. We have seen how, in the Revolutionary period, theatres were closed by act of Congress, doubtless because, in those days of danger, the fathers of our country felt that they would help their cause by propitiating the Almighty, who was supposed to frown upon godless amusements. But in the last three or four decades this unreasonable prejudice against the most enjoyable and least harmful of all forms of amusement has so materially lessened that it is estimated by a good authority that not more than one-tenth of the people refuse to patronize the theatres as a matter of principle. It is true that a clergyman now and then inveighs against the stage in the old-fashioned, puritanical way; but his words, in all likelihood, fall upon ears that the night before were listening to the sorrows of 'Camille' or were taking in the laughter-provoking catch-lines of 'The Private Secretary.' Indeed, the element of moral usefulness in the theatre is no longer successfully derided.

The phenomenal development of the moving picture theatre has made many changes in the stage since the dawn of the 20th century. Those theatre managers who clung to the regularly staged productions of the old school suffered in business, and there were years of depression and numerous failures. Some tried to bring back the crowds by going the limit in presenting plays exhibiting crime, and for a few seasons there was scant decency in many American playhouses. When this failed, the more sensible managers accepted the moving picture as an adjunct, and many utilized it as a vaudeville feature. The war also had a disintegrating influence; many of the younger actors put on the uniform and were lost to the profession. War plays were called for, and a few strong productions resulted. The number of new plays produced in America is small, however. About 100 are staged annually in New York City, and perhaps a dozen in other cities. Those that run more than 100 nights are voted to be great successes. The remainder of the performances in New York are either reproductions of European authors, or old plays revived. It is not possible to catalogue the best plays that come and go, though many of them will be found by reference to DRAMA. See also MOVING PICTURES.

NAMES OF SOME FAMOUS ACTORS.

Professional	Real
Abingdon, Wm. L.	Pilgrim, Wm. Lepper.
Abott, Bessie	Story, Mrs. T. W.
Adams, Maude	Kiskadden, Maude.
Albani, Mme	Gye, Mrs. Ernest.
Alda, Frances	Gatti-Casazza, Mrs. G.
Alexander, Sir George	Sampson, Sir George.
Allen, Viola	Duryea, Mrs. Peter.
Anderson, Mary	Navarro, Mrs. A. F. de.
Anglin, Margaret	Hull, Mrs. Howard.
Arliss, George	Arliss-Andrews, George.
Arthur, Julia	Cheney, Mrs. Benj. P.
Ashley, Minnie	Chanler, Mrs. Wm. A.
Baird, Dorothea	Irving, Mrs. Henry B.
Barrymore, Ethel	Colt, Mrs. Russell G.
Barrymore, John	Blythe, John.
Bateman, Kate	Crowe, Mrs. George.
Bates, Blanche	Creel, Mrs. George.
Bentley, Irene	Smith, Mrs. Harry B.
Bernard, Sam	Barnett, Sam.
Bernhardt, Sarah	Damala, Mme.
Blair, Eugenie	Downing, Mrs. Eugenia.
Blauvelt, Lillian Evans	Pendleton, Mrs. W. F.
Booth, Rachel	Powers, Mrs. Jas. T.
Buffalo Bill	Cody, William F.
Burke, Billie	Ziegfeld, Mrs. Florenz.
Burnett, Frances H	Townsend, Mrs. S.
Burroughs, Marie	Livingston, Mrs. Francis M.
Burt, Laura	Stamford, Mrs. Hy. B.
Busley, Jessie	Joy, Mrs. E. C.
Cahill, Marie	Arthur, Mrs. Daniel V.
Calvé, Emma	Gaspari, Mme. Alnor.
Cameron, Beatrice	Mansfield, Mrs. Richard.
Cameron, Violet	De Bensaude, Mrs.
Campbell, Mrs. Patrick	West, Mrs. G. Cornwallis.
Carle, Richard	Carleton, Chas. N.
Carter, Mrs. Leslie	Payne, Mrs. Wm. L.
Carus, Emma	Everall, Mrs. Harry J.
Castle, Vernon	Blythe, Vernon Castle.
Cavalieri, Lina	Muratore, Mrs. L.
Chase, Pauline	Drummond, Mrs. Alex.
Claire, Ina	Fagan, Miss.
Claxton, Kate	Stevenson, Mrs. Chas. A.
Coghlan, Gertrude	Pitou, Mrs. A., Jr.
Coghlan, Rose	Sullivan, Mrs. John.
Conquest, Ida	Bertelli, Mrs. Riccardo.
Corinne	Flaherty, Corinne K.
Cowl, Jane	Klauber, Mrs. Adolph.
Crosman, Henrietta	Campbell, Mrs. Maurice.
Dale, Alan	Cohen, Alfred J.
D'Arville, Camille	Crellin, Mrs. E. W.
Davis, Fay	Lawrence, Mrs. Gerald.
Dazie, Mlle	Fellowes, Mrs. Cornelius.

NAMES OF SOME FAMOUS ACTORS — *Continued.*

Professional	Real
De Silva, N.	Harvey, Mrs. Martin.
Dockstader, Lew	Clapp, Geo. Alfred.
Doro, Marie	Dexter, Mrs. Elliott.
D'Orsay, Lawrance	Dorset, Wm. Lawrance.
Dorr, Dorothy	Dam, Mrs. Hy. J. W.
Dressler, Marie	Dalton, Mrs. Jas. H.
Duse, Eleanora	Cecci, Signora.
Eames, Emma	Gogorza, Mme. Emilio de.
Elliot, Gertrude	Forbes-Robertson, Lady.
Ellsler, Effie	Weston, Mrs. Frank.
Eltinge, Julian	Dalton, William.
Farrar, Geraldine	Lou-Tellegen, Mrs.
Fealy, Maude	Durkin, Mrs. James.
Ferguson, Elsie	Clarke, Mrs. Thomas B.
Filkins, Grace	Marix, Mrs. Adolph.
Fischer, Alice	Harcourt, Mrs. Wm.
Fiske, Minnie Maddern	Fiske, Mrs. Harrison Grey.
Forbes-Robertson, Beatrice	Hale, Mrs. Swinburne.
Fornia, Rita	Laboy, Mrs. James P.
Foy, Eddie	Fitzgerald, Edward.
Gadski, Johanna	Tauscher, Mme. H.
George, Grace	Brady, Mrs. W. A.
Gilman, Mabelle	Corey, Mrs. W. E.
Glaser, Lulu	Richards, Mrs. Thos. D.
Glück, Alma	Zimbalist, Mrs. Efram.
Gordon, Kitty	Beresford, Mrs. Harry.
Guilbert, Yvette	Schiller, Mrs. Max.
Hare, Sir John	Fairs, Sir John.
Harned, Virginia	Courtenay, Mrs. Wm.
Haswell, Percy	Fawcett, Mrs. Geo.
Herne, James A.	Ahern, James.
Heron, Bijou	Miller, Mrs. Henry.
Holland, Mildred	White, Mrs. Edw. C.
Hopper, Edna Wallace	Brown, Mrs. A. O.
Illington, Margaret	Bowes, Mrs. Edward J.
Irving, Isabel	Thompson, Mrs. W. H.
Irwin, May	Eisfeldt, Mrs. Kurt.
Janis, Elsie	Bierbower, Elsie Janis.
Jeffreys, Ellis	Skelton, Mrs. H. Sleatn.
Joyce, Alice	Moore, Mrs. Tom.
Karl, Tom	Carroll, Thomas.
Kelcey, Herbert	Lamb, Herbert.
Kellermann, Annette	Sullivan, Mrs. Jas. R.
Kendal, William H.	Grimston, W. H.
Kendal, Mrs. W. H.	Grimston, Mrs. W. H.
Kidder, Kathryn	Anspacher, Mrs. L. K.
Langtry, Mrs.	De Bathe, Lady Hugo G.
Lewis, Ada	Paar, Mrs. John.
Lipman, Clara	Mann, Mrs. Louis.
Loftus, Cissie	Waterman, Mrs. A. H.
Lohr, Marie	Prinsep, Mrs. A. L. V.
Lotta	Crabtree, Charlotte.
Lloyd, Alice	MacNaughton, Mrs. Tom.
Lloyd, Marie	Dillon, Mrs. B.
Macdonald, Christie	Gillespie, Mrs. Henry L.
Mack, Andrew	McAloon, William A.
Mannering, Mary	Wadsworth, Mrs. Fred E.
Marlowe, Julia	Sothern, Mrs. E. H.
Marr, Pauline	Collier, Mrs. Wm.
Martinot, Sadie	Nethersole, Mrs. Louis.
Matthison, Edith Wynne	Kennedy, Mrs. C. R.
May, Edna	Lewisohn, Mrs. O.
Mayhew, Stella	Taylor, Mrs. Billie.
Mayo, Margaret	Selwyn, Mrs. Edgar.
McCarthy, Lillah	Barker, Mrs. H. Granville.
McLean, R. D.	Shepherd, R. D.
Melba, Mme	Armstrong, Mrs. N.
Millard, Evelyn	Coulter, Mrs. Robt. P.
Millward, Jessie	Glendinning, Mrs. J.
Mitchell, Maggie	Abbott, Mrs. Chas.
Moore, Mary	Albery, Mrs. James.
Moore, Eva	Esmond, Mrs. H. V.
Morris, Clara	Harriott, Mrs. F. C.
Murray, Alma	Forman, Mrs. Alfred.
Nazimova, Alla	Bryant, Mrs. Chas. E.
Neilson, Julia	Terry, Mrs. Frederick.
Neilson-Terry, Phyllis	King, Mrs. Cecil.
Nevada, Emma	Palmer, Mrs. Raymond.
Nielsen, Alice	Nentwig, Mrs. Benj.
Nilsson, Christine	Miranda, Comtesse de.
Noria, Jane	Centanini, Mrs. G. P.
Olcott, Chauncey	Olcott, Chancellor J.
Opp, Julie	Faversham, Mrs. W. F.
O'Neill, Anne	Thomas, Mrs. A. M.
O'Neill, Nance	Hickman, Mrs. Alfred.
Palmer, Minnie	Rogers, Mrs. John R.
Parker, Flora	De Haven, Mrs. Carter.
Patti, Adelina	Cederstrom, Baroness.
Phillips, Frank	Fein, Philip.
Pickford, Mary	Moore, Mrs. Owen.
Polaire, Mlle	Zouzé, Emillie.
Powell, Maud	Turner, Mrs. H. Godfrey.
Rankin, Phyllis	Davenport, Mrs. Henry L.
Reeve, Ada	Cotton, Mrs. Wilfred.
Rice, Fannie	Ryder, Mrs. Paul W.

NAMES OF SOME FAMOUS ACTORS — *Concluded.*

PROFESSIONAL	REAL
Ring, Blanche	Winninger, Mrs. Chas.
Ritchie, Adele	Post, Mrs. Guy Bates.
Robson, Eleanor	Belmont, Mrs. August.
Robson, May	Brown, Mrs. Augustus H.
Rorke, Kate	Cree, Mrs. Douglas.
Rorke, Mary	St. Aubyn, Mrs. F. W.
Ross, Chas. J.	Kelly, Chas. J.
Russell, Annie	Yorke, Mrs. Oswald.
Russell, Lillian	Moore, Mrs.
Sanderson, Julia	Barnette, Mrs. B.
Sembrich, Marcella	Stengel, Mme. Guillaume.
Shannon, Effie	Lamb, Mrs. Herbert.
Simone, Mme	Perier, Mme. Casimir.
Stahl, Rose	Bonelli, Mrs. Wm.
Stanhope, Adeline	Wheatcroft, Mrs. N.
Stirling, Mme. A.	Mackinlay, Mrs. J.
Stuart, Cosmo	Gordon-Lennox, Cosmo.
Summerville, Amelia	Stepan, Mrs. Max E.
Taliaferro, Mabel	Corrigan, Mrs. Thos. J.
Tanguay, Eva	Ford, Mrs. John W.
Taylor, Laurette	Manners, Mrs. J. H.
Tempest, Marie	Gordon-Lennox, Mrs. Cosmo.
Templeton, Fay	Patterson, Mrs. William.
Terry, Ellen	Carew, Mrs. James.
Tetrazzini, Luisa	Bazelli, Sra.
Tilley, Vesta	De Frece, Mrs. W.
Titheradge, Madge	Quartermaine, Mrs. Chas.
Tree, Sir H. Beerbohm	Birnbaum, Henry.
Trevelyan, Hilda	Blow, Mrs. Sydney.
Truax, Sarah	Albert, Mrs. Chas. S.
Tyler, Odette	Shepherd, Mrs. R. D.
Vanbrugn, Violet	Bourchier, Mrs. Arthur.
Victoria, Vesta	Terry, Mrs. Herbert.
Vincent, Ruth	Fraser, Mrs. John.
Wainwright, Marie	Roberts, Mrs. Franklyn.
Walker, Charlotte	Walter, Mrs. Eugene.
Ward, Fannie	Dean, Mrs. Jack.
Ward, Genevieve	de Guerbel, Countess.
Ware, Helen	Remer, Miss Helen.
Waring, Herbert	Rutty, Herbert W.

FAMOUS MOVING PICTURE ACTORS.

Name	Born
Ahern, George	Newark, Cal., 1888.
Allison, May	Georgia, 1895.
Ashley, Arthur H.	Brooklyn, N. Y., 1886.
Baggot, King	Saint Louis, Mo., 1879.
Baird, Leah	Chicago, Ill., 1887.
Banks, Perry	Victoria, B. C., 1877.
Bara, Theda	Sahara, Africa, 1890.
Barriscale, Bessie	New York City, 1891.
Bayne, Beverly	Minneapolis, Minn., 1893.
Beaumont, Harry	Abilene, Kan., 1888.
Boardman, True	Oakland, Cal., 1885.
Borzage, Frank	Salt Lake City, Utah, 1893.
Brady, Alice	New York City, 1892.
Brice, Rosetta	Sunbury, Pa., 1892.
Briscoe, Lottie	Saint Louis, Mo., 1893.
"Bud" (A. E. Duncan)	Brooklyn, N. Y., 1886.
Bushman, Francis X	Norfolk, Va., 1885.
Carroll, William Arthur	New York City, 1877.
Castle, Mrs. Vernon	New Rochelle, N. Y., 1892.
Chaplin, Charlie	London, England, 1890.
Chatterton, Thomas	Geneva, N. Y., 1881.
Childers, Naomi	Pottstown, Pa., 1885.
Clark, Harvey	Boston, Mass., 1886.
Clayton, Marguerite	Salt Lake City, Utah, 1892
Cloy, May	Minneapolis, Minn., 1893.
Corbett, James J.	San Francisco, 1866.
Costello, Maurice	Pittsburgh, Pa., 1877.
Courtot, Margaret	Summit, N. J., 1897.
Cranston, Mary	Chicago, Ill., 1893.
Cruze, James	Ogden, Utah, 1884.
Cunard, Grace	Paris, France, 1894.
Dana, Viola	Brooklyn, N. Y.
Daniels, Bebe	Dallas, Tex., 1901.
Darling, Grace	New York City, 1896.
Daw, Marjorie	Colorado Springs, Colo., 1901.
Dearbolt, Ashton	Milwaukee, Wis., 1894.
Dill, Max M.	Cleveland, Ohio, 1877.
Drew, Lillian	Chicago, Ill., 1886.
Drew, Sidney	New York City, 1864.
Dunaew, Nicholas	Moscow, Russia, 1884.
Eagels, Jeanne	Kansas City, Mo., 1894.
Edmondson, Harry B.	Baltimore, Md., 1873.
Finch, Flora	England, 1877.
Ford, Francis	Portland, Me., 1883.
Forman, Tom	Texas, 1893.
Fox, Harry	Pomona, Cal., 1886.
Fuller, Mary	Washington, D. C., 1893.
Garwood, William	Springfield, Mo., 1887.
Gebhart, George	Basle, Switzerland, 1879.
Gibson, Helen	Cleveland, Ohio, 1894.

Famous Moving Picture Actors — *Concluded.*

Name	Born
Gish, Lillian	Springfield, Mo., 1896.
Gough, John	Boston, Mass., 1897.
Gray, Robert	Maine, 1888.
Green, Dorothy	Moscow, Russia, 1895.
Hahn, Philip	Amsterdam, Holland, 1884.
"Ham" (L. V. Hamilton)	Oakland, Cal., 1891.
Hatton, Raymond	Iowa, 1887.
Hayakawa, Sessue	Tokio, Japan, 1889.
Henley, Hobart	Louisville, Ky., 1886.
Hollis, Hylda	Philadelphia, Pa., 1880.
Hulette, Gladys	Arcade, N. Y., 1899.
Johnson, Arthur	Cincinnati, Ohio, 1876.
Joy, Ernest	Minneapolis, Minn., 1891.
Joyce, Alice	Kansas City, Mo., 1889.
Joyner, Francis	New Orleans, La., 1887.
Kane, Gail	Philadelphia, Pa., 1887.
Kellard, Ralph	New York City, 1887.
Kennedy, Mary	Florida, 1897.
Kenyon, Doris	Bridgeport, Conn., 1897.
Kerrigan, J. Warren	Louisville, Ky., 1890.
King, Anita	Chicago, Ill., 1892.
Kirby, Ollie	Philadelphia, Pa., 1896.
Kolb, C. William	Cleveland, Ohio, 1875.
La Badie, Florence	Montreal, Canada, 1894.
Larkin, George	New York City, 1892.
Lloyd, Harold	Burchard, Neb., 1893.
Lockwood, Harold	Brooklyn, N. Y., 1888.
MacDermott, Marc	London, England, 1881.
Marshall, Betty	Brooklyn, N. Y., 1890.
Martin, Vivian	Sparta, Mich., 1898.
McCabe, Harry	Chicago, Ill., 1879.
McRae, Duncan	London, England, 1881.
Meighan, Thomas	Pittsburgh, Pa., 1884.
Mersereau, Violet	New York City, 1896.
Millarde, Harry	Cincinnati, Ohio, 1889.
Minter, Mary Miles	Shreveport, La., 1902.
Moore, Tom	Ireland, 1887.
Moreno, Antonio	Madrid, Spain, 1888.
Morrison, Adrienne	New York City, 1887.
Morrison, Chick	Mount Morrison, Colo., 1878.
Murnane, Allan	Philadelphia, Pa., 1882.
Neilson, Anna	Stockholm, Sweden, 1890.
Newton, Charles	Rochester, N. Y., 1874.
Ogle, Charles	Zanesville, Ohio, 1865.
Oland, Warner	Sweden, 1880.
Ostriche, Muriel	New York City, 1898.
Overton, Evart	Osborne, Ohio, 1889.
Pearson, Virginia	Louisville, Ky.
Pennington, Ann	Camden, N. J.
Periolat, George E	Chicago, Ill., 1873.
Petrova, Olga	Warsaw, Poland, 1885.
Phillips, Dorothy	Baltimore, Md., 1892.
Pickford, Mary	Toronto, Canada, 1893.
Pretty, Arline	Washington, D. C., 1893.
Rale, W. W	Russia, 1868.
Reichenbach, Harry	Cumberland, Md., 1883.
Reid, Wallace	Saint Louis, Mo., 1892.
Ridgely, Cleo	New York City, 1893.
Ritchie, Billie	Glasgow, Scotland, 1877.
Robbins, Edwina	Hoboken, N. J., 1886.
Rossou, Helene	Newport, R. I., 1898.
Russell, Wm. F	New York City, 1886.
Sais, Martin	California, 1893.
Sears, Laura	Staten Island, N. Y., 1893.
Shafer, Mollie	Woodland, Cal., 1874.
Shelby, Margaret	San Antonio, Tex., 1900.
Sherrill, Jack	New York City, 1897.
Shotwell, Marie	New York City, 1886.
Snow, Marguerite	Savannah, Ga., 1892.
Spingler, Harry	Buffalo, N. Y., 1889.
Stewart, Anita	Brooklyn, N. Y., 1895.
Storey, Edith	New York City, 1892.
Stowell, Wm. H	Boston, Mass., 1883.
Talmadge, Constance	Brooklyn, N. Y., 1899.
Tedmarsh, W. J	London, England, 1876.
Thomas, Lizette	Birmingham, England, 1889.
Van Tassell, Marie	Fort Edward, N. Y., 1880.
Vernon, Agnes	Oregon, 1896.
Walcamp, Marie	Dennison, Ohio, 1894.
Walker, Lillian	Brooklyn, N. Y., 1888.
Warwick, Robert	New York City, 1882.
Washburn, Bryant	Chicago, Ill., 1889.
Wells, Kittie	Shreveport, La., 1894.
White, Pearl	Missouri, 1889.
Williams, Earle	Sacramento, Cal., 1880.
Yost, Herbert	Cincinnati, Ohio, 1883
Young, Clara Kimball	Benton Harbor, Mich., 1891.

THEATRE, Stage Mechanics of. A theatre stage is that visible part of a platform arranged at one end of an auditorium which is enclosed by scenery and framed within and viewed through an opening or arch. The stage and all that may be arranged upon it should be preservative of the lines of sight and hearing of the spectator and auditor.

From earliest times either an elevation or platform, or a depression or pit, have been usual for representation or entertainment before spectators. The earliest choral dances in the circle or pit evolved into the Greek classic theatre, with its skene or house of two or three stories, which filled the background of the scene, the action being within the semi-circular chorus place or pit in front.

The mechanism of the ancient theatre was very exact in every respect. The religious character of the performance established fixed and usually theologic meanings for everything done or said in the play. The scenery was probably limited to painted curtains at the back and revolving triangular prisms at entrances. Machinery for startling effects was, however, usual. The Roman invasion resulted in the extension of the stage more and more forward, until it became a platform sufficiently large to hold the chorus and entire group of performers.

The ancient Greeks bore the same relation in art and theatricals to the world of their time as the modern French do to-day; consequently even the traveling companies of the various nations followed crudely the methods of performances usual with the Greeks, and, indeed, the general conduct and character of the modern theatre has in many important respects followed the original classic traditions. The entrances and exits on the modern stage, much of the symbolic values of parts of the stage and the arrangement of stage movement are directly inherited from the old Greek theatre: In later mediæval times a portable stage or cart was used. But little advance can be noted in stage mechanism until after the time of Shakespeare and of Molière, when modern inventions began to appear. Richard Wagner and the Germans revolutionized stage settings and theatrical architecture, as notable in Wagner's Theatre in Baireuth and the Burg Theatre in Vienna. The Germans' leadership in applying science to and otherwise improving stage mechanics has been followed by every European nation, notably in England, by Sir Henry Irving, whose system of lighting is especially remarkable in the conveyance of the feeling of atmosphere to the senses of the spectators. In America Steele Mackaye was progressive in improving the mechanism of the stage. Later, the proprietors of the New York Hippodrome developed most elaborate and complicated mechanisms for spectacular productions.

While the use of gas and movement of scenery in grooves had been universal during the past century until 1875, yet in many theatres to-day such modes of lighting and scene shifting are still retained. In the theatres of to-day, where electricity and the most modern machinery are employed, the following are the terms and uses of the stage machinery:

The Stage.

Rake, The.— The scale or rise of the stage floor, from the curtain line to the back wall. A modern stage is generally built with a slight downward incline toward the audience. The "Rake" of the scenery is the perspective line; a gradual decrease in the height of each piece of the sides of a scene representing an interior or room and extending up stage.

Proscenium Arch, The.— The architectural arch and sides behind which descends the curtain — as it were a massive frame to the picture which the curtain-rise reveals.

BRIDGE.— A longitudinal section of stage, built as a trussed bridge so that it can be taken out, raised or lowered as necessary for effects. Bridges are counterbalanced like elevators, and designed to carry much live weight.

APRON, THE.— That space of the stage from the curtain line down to the footlights. A distance usually of four or five feet. The apron in modern theatres is often almost eliminated.

TORMENTOR, THE.— The foremost piece of scenery standing slightly out, both sides of the stage, back of the proscenium sides. It is often red and intended as the matting to the picture framed.

FRONT DRAPERY, THE.— A short curtain stretching across the proscenium arch, intended to blend with the tormentors at the required height from the ground, once the curtain has risen, thus forming an arch matting to the picture.

FLY GALLERIES, THE.— Galleries that are built along the side walls of the stage. The height of these galleries above the stage varies according to the proportions of the stage and building. On an average they are erected some 30 feet from the ground. One of these side galleries is occupied — ordinarily the left side gallery — by the fly-men, a crew of men employed there to operate the ropes (called lines) whereby the divers pieces of scenery are either raised or lowered into position.

PAINTER'S GALLERY, THE— A long narrow bridge extending from one fly gallery to the other alongside the back wall of the stage. It is always movable and can be hoisted or lowered down any distance by means of ropes and is for the purpose of touching up scenery which may necessitate fresh daubs of paint. The scenery to be painted is hung or set flat against the back wall of the stage, and the painter's bridge is then raised or lowered in front of it, according to necessity.

RIGGING LOFT, THE.— A timber flooring some few feet beneath the roof above the stage: a network of small beams for the purpose of attaching pulleys thereto — whereby pieces of scenery, borders, etc., may be raised from the ground or lowered. The rigging loft is ordinarily built 50 feet above the stage, sometimes even higher; this to afford more room for the hoisting and retention of stacks of scenery above the setting. The pulleys are attached to the rigging loft in rows of threes, from the front of the stage to the back of the stage. In each row one pulley occupies the centre of the rigging loft; the two others occupy the left and the right of the central pulley and are stationed half way between the central one and the edge of the rigging loft. To each of these numerous rows of pulleys are affixed long ropes, one end of which is carried down by a small weight, while the other end is securely fastened in the fly galleries, usually the left gallery.

PINS, COUNTERWEIGHTS, SAND-BAGS.— The "Pin" is a bar of cast iron, 15 inches long by 1¼ inches in diameter. Pins, sand-bags and counterweights are attached to the loose end of the rope which drops toward the stage from the rigging loft. These weights are usually removed when a piece of scenery is fastened to the rope in their place.

NOISE MACHINES.— A tumble-box filled with old iron, stones, etc., that can be made to deliver almost any degree of loud noises. Also a sheet iron apparatus that when shaken resembles thunder in the sound emitted.

SNOW MACHINE.— A mechanism for dropping a shower of small bits of white paper to imitate falling snow.

LINES.— The ropes that are thus held in the rigging loft and manipulated from the fly gallery.

CENTRE LINE, THE.— The rope attached to the pulley stationed in the centre of the rigging loft, and dropping toward the centre of the stage.

LONG LINE, THE.— The rope attached to that pulley which is farthest from the side from where it is being manipulated in the fly gallery.

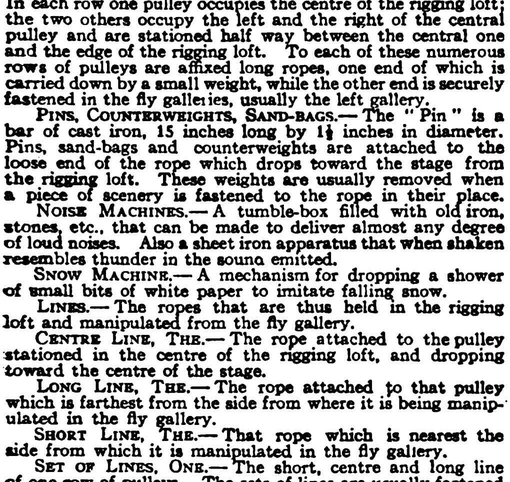
SHORT LINE, THE.— That rope which is nearest the side from which it is manipulated in the fly gallery.

SET OF LINES, ONE.— The short, centre and long line of one row of pulleys. The sets of lines are usually fastened together on the pegs in the fly gallery.

TRAPS.— A concealed opening in the floor of the stage.

STAGE POSITIONS.

The stage is divided into imaginary lines and spaces — which enable the performers to cross, inter-cross and



circle around each other without confusion — and as well the stage carpenter to erect his scene, and the stage-hands to set their furniture in the proper places.

It is assumed that there are four entrances. These are counted 1, 2, 3, 4, from down stage up.

N. B.— Though there may be but one entrance on one side of the interior setting — direction may possibly be given to set a fireplace or window R.2. (right second); that is to say, where right second entrance should have been had it existed.

EXPLANATION OF THE ABBREVIATIONS.

R. 1. E.— Right first entrance.
R. 2. E.— Right second entrance.
R. 3. E.— Right third entrance.
R. 4. E.— Right fourth entrance.
L. 1. E.— Left first entrance.
L. 2. E.— Left second entrance.
L. 3. E.— Left third entrance.
L. 4. E.— Left fourth entrance.
C.— Centre of stage.
D. C.— Down centre line.
U. C.— Up centre line.
U. R. C.— Up right centre line.
R. C.— Right centre line.
D. R. C.— Down right centre line.
U. L. C.— Up left centre line.
L. C.— Left centre line.
D. L. C.— Down left centre line.
D. R.— Down right of stage.
D. L.— Down left of stage.
L.— That side of the stage which is left of a person facing the audience.
R.— That side of the stage which is right of a person facing the audience.
U. R.— Up right of stage.
U. L.— Up left of stage.

THE SCENERY.

WING, A.— A single piece of scenery, ordinarily 5 feet 4 inches wide by 18 feet high.

FLAT, A.— A double wing, either hinged or battened together.

BORDERS.— Strips of canvas hung crosswise above the stage by means of a set of lines. These may either represent the sky, the branches of trees and foliage, etc.

CEILING.— A square of canvas set to a light frame of wood which is lowered by means of a double set of lines— one set "up stage" (back of stage), the other "down" (front of stage), until it rests squarely upon the interior set.

BOX SET, A.— A complete interior setting.

DROP, A.— A large canvas representing the back-ground of the setting. In the case of a complete exterior setting, the drop extends the full width of the back of the stage; in the case of an interior setting, where, for example, only a window and a door present a view of the outside, the drop may be much narrower.

TAB, A.— A narrow drop, hung by a single line.

JOG, A.— A narrow piece of scenery, wherewith two flats or wings of an interior setting may be joined, either for extension or to form a quadrangle.

RETURN PIECES.— Two wings affixed to an interior setting, which turn off stage, back of each side of the proscenium opening.

BACKINGS.— Either a wing, or two wings hinged together, set back of some opening, window or door.

MASKING PIECES.— A piece of scenery, tab, drop or wing, set behind an opening to conceal either the scenery or the bare stage immediately behind it.

BRACES.— Two narrow strips of wood, five feet long, either permitted to slip alongside each other or made fast to each other by means of a turn-screw once the desired extension is reached. The top end has a small iron grip attached, in the shape of a ram's horns; the lower has a narrow short blade of steel intended to trail flat upon the ground and containing a hole sufficiently large to admit a screw-pin. The grip at the top of the brace is first introduced into a screw-eye attached to the back of a piece of scenery; then the desired length of the brace is secured by means of the centre screw, so that it reaches the ground obliquely; lastly, then, the screw-pin fastens the brace securely to the ground: and thus may scenery be held in position.

LASHLINES.—Pieces of light rope fastened at the side of the wooden frame near the top of a wing or flat, for the purpose of fastening this wing or flat to the next one.

THE LIGHTS.

FOOTLIGHTS (of the stage.)— Rows of lights along the front edge of the stage.

BORDER LIGHTS.—The illumination of a series of electric bulbs in a long tin reflector, extending the full width of the stage and hung up in the air, by means of a set of lines, back of the canvas borders. There are usually four border lights, more or less, according to the depth of the stage and the style of the play: No. 1 border light is hung close to the curtain down stage; No. 4 is hung well back of stage; the other two, Nos. 2 and 3, occupy the intersecting positions.

STRIPS.— Several electric bulbs set to a narrow strip of wood, varying in length according to necessity — usually our feet long, which may be movable and hung anywhere back of the setting.

BUNCH LIGHT.— Several electric bulbs inside of circular and movable tin-reflector.

BOX CALCIUM.— An oval, sheet-iron box with an open front 18 inches by 14 inches, set upon a long steel rod encased in a tubing — for the purpose of raising or lowering. The box is painted white within and contains carbon holders and carbon sticks — and is for the purpose of throwing a wide flood of white or colored light.

MEDIUMS.— A light frame of wood, the size of the opening of the box calcium. The space within this frame is filled with a thin sheet of gelatine: the gelatine being colored either red, blue, green, amber, etc. Thus sunset glow, moonlight, sunlight effects may be secured by the use of a different medium.

LENSES.— A sheet-iron hood, set to a steel rod and operated in the same way as the box calcium, but for the purpose of throwing a shaft of light: that is, a moonbeam, a sunbeam.

POCKETS.— Concealed, safety, steel pockets in the floor of the stage, on both sides, for the purpose of connecting wires, leading to calciums, bunch lights, etc. Usually there are three pockets on each side of the stage.

THE SWITCH-BOARD.— The electric board — usually on the prompt side — where all connections are made for the electricians to operate all the lights from a single place.

For greater detail consult Gerhardt, W. P., 'Theatres: Their Safety, Comfort and Healthfulness' (New York 1915).

J. M. EDGAR HART,
Instructor of the American Academy of Dramatic Arts.

THÉÂTRE FRANÇAIS, tā-ätr frän-sā. See COMÉDIE FRANÇAISE.

THEATRE LIBRE, lēbr, in France, a theatre for the populace, subsidized by the government and admission to which is practically free to all citizens of the republic.

THEATRICALS, Amateur. See AMATEUR THEATRICALS.

THEBAN CYCLE. A series of old Greek epic poems dealing with Theban legends. They include 'Thebais,' which tells the story of the house of Labdacus and the attack of the Seven on Thebas; the 'Epigone,' which relates the capture of the city, and the 'Œdipœdia,' which tells the story of the hero Odipus. The poems average about 6,000 lines each.

THEBES, thēbz (Egyptian *Net,* the *No* of the Bible; Greek *Thebai* or *Diospolis*), Egypt, a famous ancient city, whose ruins are situated on the banks of the Nile, 350 miles southeast of Cairo, near the modern villages of Karnak and Luxor. The ruins are among the most magnificent in the world. The largest is the great temple of Ammon at Karnak on the east bank of the river. It was begun during the Twelfth Dynasty and enlarged by the kings of the succeeding dynasties down to the time of the Ptolemies. It stands within a large enclosure which also contains several minor temples. An avenue of sphinxes leads to the main entrance, which is a huge pylon, 142 feet high. This leads into a court measuring 276 by 338 feet, and traversed by a double line of colossal columns. A second pylon leads into the great hall or hypostyle, whose roof was supported by 134 columns in 16 rows. The columns of the two central rows are 78 feet high and 33 feet in circumference. All were brilliantly painted and sculptured, and many of the columns still retain their bright colors. Other pylons lead into the inner courts, one of which contains two obelisks 97½ feet high and a colossal statue of Osiris. One of the obelisks is still erect. The entire structure is 1,200 feet long and about 350 feet wide. At Luxor, also on the east bank of the river, and a short distance south of Karnak, there are fine ruins of another temple of Ammon, built by Amenophis III and his successors. On the west bank the principal ruins are the Tombs of the Kings, hewn into the solid rocks of the hillside; the Ramesseum, a temple of Ammon built by Rameses II, and containing a colossal statue of that king; and the two Colossi of Memnon, 64 feet in height. One of these is the celebrated «vocal statue.» Numerous other remains of tombs and temples are scattered over the neighborhood on both sides of the river. After the expulsion of the Hyksos Thebes became the capital of Egypt and remained so until the beginning of the Twenty-first Dynasty. It declined in importance after this with the exception of a short period in the 7th century B.C., when it was again the capital. The Ptolemies repaired its great buildings and so did the Romans. In 27 B.C. an earthquake worked havoc with its ancient ruins. Since then Thebes is nothing more than a collection of ruins inhabited by a few Arab families of Fellahin, who obtained a precarious livelihood by guiding travelers over the ruins or rifling the tombs for antiquities. Consult Davies, N. de G., 'Five Theban Tombs' (in Archæological Survey of Egypt, 'Memoir 21,' London 1913); *Bulletin* of the Metropolitan Museum of Art (New York 1914); Lepsius, Karl, 'Denkmäler Aus Aegypten und Aethiopen' (Berlin 1850–59); Mariette, A. E., 'Monuments of Upper Egypt' (London 1877); Naville, E. H., 'Deir El-Bahari' (London 1894-1906). See also EGYPT.

THEBES (Greek, *Thēbai*), Greece, the principal city of Bœotia, was situated on an elevated plateau, south of Mount Phaga, its site now being occupied by the unimportant modern town of Thivæ (pop. 3,500), at the junction of the road leading north from Athens, with the transversal road leading from the Strait of Euripos on the east to the Gulf of Corinth on the west. It was one of the most celebrated cities of Greece, the birthplace of Pindar, Epaminondas, and Pelopidas. Cadmus, leading thither a Phœnician colony, is said to have founded the city by building the citadel called Cadmeia (1500 B. C.). The principal name in the legendary history of Thebes is that of Œdipus. The first recorded event in its history took place in 728 B.C., when Philolaus drew up a code of laws for the Thebans. During the Persian wars it lost much of its influence in Greece through its perfidious leagues with the Persians. In the Peloponnesian War the Thebans rendered important services to the Spartans; but they afterward, through jealousy of the Spartan power, joined the confederacy against them in 394. In 382, though peace then prevailed, Phœbidas, the Spartan commander, treacherously possessed himself of the Cadmeia, which was held by the Spartans until Pelopidas and Epaminondas headed a conspiracy which resulted in the death of the tyrants (378 B.C.). Open war now broke out between Sparta and Thebes, which resulted in the humiliation of the former by the crushing defeat of Leuctra (371). Thebes, under the brilliant leadership of Epaminondas and Pelopidas was now the leading state in Greece, but its supremacy departed when the former fell at the battle of Mantinea (362 B.C.). On the rise of the Macedonian power Thebes entered into an alliance with the Athenians and other Greeks against Philip. After the battle of Chæronea (338 B.C.) it was obliged to receive a Macedonian garrison. On Philip's death an insurrection broke out in Thebes and an attempt was made to drive the Macedonians from the Cadmeia. But Alexander hastened to their relief, captured and destroyed (336 B.C.) the city, and reduced the inhabitants to slavery. Twenty years afterward Cassander rebuilt Thebes; but it never recovered its former importance. In the war of the Romans against Mithridates, king of Pontus, it joined the latter out of gratitude to Athens, and was severely chastised by the Romans under Sulla. From this time the Thebans as a power in Greece gradually disappear from history. In the 11th and 12th centuries it was again in a prosperous condition as a result of the introduction of silk manufacturing. It was sacked by the Normans in 1146. Consult Baedeker, Karl, 'Greece' (4th Eng. ed., Leipzig 1909); Fabricius, E., 'Theben' (Freiburg 1890); Müller, M., 'Geschichte Thebens' (Leipzig 1879); Stern, E. von, 'Geschichte der spartanischen und thebanischen Hegemonie' (Dorpat 1884).

THECLA, thĕk'la, **Saint,** the female protomartyr of the Church. Born of a noble family of Iconium in Lycaonia, she was converted by the preaching of Saint Paul, followed him to Antioch and devoted herself to a life of virginity. As a consequence, she suffered a series of persecutions from her fiancé and her parents, who eventually denounced her to the authorities as a Christian, and she was thrown to the wild beasts in the theatre; but the fierce animals refused to hurt her, and she also escaped unscathed from the flames to which she was subsequently exposed. After the death of Saint Paul she lived to a ripe old age in a cell near Seleucia. She is the heroine of a Christian romance of the 2d century called 'The Acts of Paul and Thecla.' (See APOCRYPHA). Consult Schlan, 'Die Akten des Paulus und die ältere Theklalegende' (1877); Schmidt, C., 'Acta Pauli' (Leipzig 1905); Ramsay, 'The Church in the Roman Empire' (London 1893).

THECOPHORA, a suborder of *Chelonia* (q.v.), containing all except the leathery turtles (*Athecæ*). It is defined by anatomical characters, the most conspicuous of which is the exclusive possession of horny epidermal shields or plates on the shell. Consult Gadow, 'Amphibia and Reptiles' (New York 1901).

THEFT, is a term sometimes used as synonymous with larceny, although it is less technical, and a wider term, and signifies the secret and felonious abstraction of the property of another with the intention of converting it to the taker's use, and without the consent of the owner. See LARCENY.

THEINE, $C_8H_{10}N_4O_2$, more often called caffeine, an alkaloid found in tea, coffee, Paraguay tea, guarana, etc. It may be prepared synthetically by action of methyl iodide on theobromine. Usually obtained from tea dust which contains from 2 to 4 per cent white silky needles, slightly soluble in cold water and alcohol, possessing a somewhat bitter taste, and forming salts with acids. It is used in medicine as a nerve stimulant.

THEISM, the doctrine of the existence of a God or Gods. It may take the form either of monotheism or polytheism and is opposed only to atheism, which denies the existence of such divine beings. From its use to express the belief of cultured Christian peoples, the term has been given a more restricted meaning. Thus, theism has been identified with monotheism, as implying belief in one God, and hence is distinguished from all forms of polytheism. Further, theism is distinguished from pantheism on the one hand and deism on the other. Pantheism (q.v.) merges God with the world-process and thus practically denies his personality. Deism (q.v.) emphasizes the personality of God, but conceives him as existing apart from the world of his creation. Theism endeavors to rise above both of these extremes and embrace the truth contained in each. On the one hand it maintains the personality of God and his transcendence of the world. On the other it insists upon the immanence of God, upon his presence in the world as its controlling and life-giving agency. Thus the God of theism is at once the Author and the Preserver of the world. In every age and among every people of history some form of theism is to be found as the basis of religious observance. This belief is refined and developed with the progress of thought and civilization and the direction of this development is generally in the line above mentioned, from polytheism to monotheism, and on to a comprehensive theism. Thus the traditional polytheism of Greece broke down under the influence of philosophic reflection; but this reflection itself culminated in the theistic philosophy of Aristotle. As the theoretical basis of religion and the ultimate explanation of the universe, theism has always had a prominent place in systematic reflection. In the earlier centuries of the Christian era it was the topic of supreme importance and the best effort of theologians and philosophers was given to its discussion and exposition. As a result, certain proofs for the existence of God were formulated, the most important of which possess considerable historic interest. We may mention three of these arguments: (1) The Ontological argument, first proposed by Anselm, infers the existence of God from the idea of a most Perfect Being. The presence of this idea in the human mind entails the existence of such a Being, for existence is one of the perfections necessarily contained in the idea of Most Perfect Being. (2) The Cosmological argument was adapted from Aristotle, and proceeds upon the principle that every effect must have a cause. The world is such an effect. It is impossible to suppose that the series of natural causes goes back to infinity, and consequently we are compelled to assume the existence of a Divine First Cause, adequate to account for the existence of the world. (3) The Teleological argument is based upon the evidences of design in the world, and infers therefrom the existence of a designing mind as its Author. These formal arguments were subjected to a destructive criticism by the philosopher Kant at the end of the 18th century. He attempted to show how they depended one upon the other, and all contained contradictions and inconsistencies. Kant held that the moral argument was the only possible proof for the existence of God. This argument maintains that the existence of right and duty presupposes the existence of a God who will ultimately proportion happiness to virtue and vice versa. Kant's criticism was effective in destroying the force of the three above-mentioned proofs in their traditional formulation. Evolutionary science has also contributed to lessen the force of the cosmological and teleological arguments in their earlier and cruder statement. If the present complex condition of the world is the result of a slow process of development from a simpler condition, the need for a First Cause of the present world is less apparent. If present organic structures owe their existence to their utility (that is, are the result of natural selection), their purposiveness is explained by natural causes. But all such criticism, including that of Kant, is effective rather against the form than the substance of theistic argument. It has led only to a reconstruction of old arguments and their statement in a more adequate and convincing manner. Thus it would seem that the arguments for the existence of God are rather stronger than weaker, as the result of criticism. We can only indicate in outline what form some of these arguments have taken in recent years. (1) Belief in God is justified by the needs of human thought. The constant endeavor of the human mind, in its thought, is to introduce more perfect unity, more complete system, into its knowledge. The idea of God by virtue of its all-inclusiveness, is required as the final instrument of organization to make this unity complete; for by it the self and the world are adjusted as elements of one universal life. Thus the idea of God proves its own reality by its function in knowledge. (2) The existence of God is evidenced by the nature and development of the world. In the natural world we have a series of events related as cause and effect, and each dependent upon the other. Since each component part is dependent upon and determined by some other part, it is impossible to conceive the whole series as standing alone. It is rather by its very nature dependent, and requires for its existence and support some ground or underlying principle that is self-determined. From the nature of the world as dependent and relative, therefore, we are led to believe in the existence of an Underlying Principle that is self-determined and absolute. If we consider next the development which the natural world has undergone we see its culmination in man with his intelligence and civilization. The character of the underlying principle or ground of any process will, of necessity, be more completely manifested as the process unfolds. Thus the intelligence and personality of man, as the outcome of the natural order, reveal to us the intelligence and personality of its Ground. (3) The ideals of human activity, both theoretical and practical, presuppose the existence of a God. The thought of man has an ideal, Truth, for which it ever strives. Yet Truth exists in no single human mind, neither is it the possession of the race. Truth as an end is too real to be imaginary, but if real it must exist somewhere. We are forced then to assume a divine mind in which Truth exists in all completeness. The same is true of the Good, the ideal of human conduct. That Good which, as moral ideal, exercises absolute authority over all men, is relative neither to individual desires nor to the desires of a society of individuals. Here, too, we are obliged to assume a Divine Personality whose plans are realized in the moral order and whose purposes are represented in the moral ideal.

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H. W. Wright,
Cornell University.

THEISS, tīs, or **TISZA,** tĭs'ŏ, Hungary, the largest tributary of the Danube and one of the most important of the country, rises in the Carpathians, being formed by the junction of numerous small mountain streams. Its course is first northwest, then southwest and west, until, after a circuitous course, it empties into the Danube. Its entire length is 800 miles, 300 of which are parallel to the Danube. The principal affluents are the Maros and Bodrog. The cities on its route are Tokay, Szolnok and Szegedin, which frequently suffer from its overflow. A memorable inundation was that of 1879, when Szegedin was overwhelmed and the entire population lost everything; the loss including many lives. Tokay is at the head of navigation. A canal connects its lower course with the Danube while the Bega Canal connects it with the Temesvár. Its basin has an area of 56,600 square miles, covering all the eastern part of Hungary and most of Transylvania.

THELLUSSON, těl'lŭs-sŏn (Fr. tā-lü-sôṅ), **Peter,** London merchant: b. Paris, 27 June 1737; d. London, 21 July 1797. He settled in London in 1762 and opened a commission house, and later acquired a large fortune by trade with the West Indies. The singular terms of his will, dated 2 April 1796, gave occasion to the passing of an act of Parliament known as the Thellusson Act. He left to his widow and family about £100,000, and the remainder, amounting to more than £600,000, he left to trustees, to accumulate during the lives of his three sons, and the lives of their sons. On the death of the last survivor the estate was to be divided equally among the eldest male lineal descendants of his three sons then living. If there were no heir the property was to go to the extinction of the national debt. This will, being contested by the heirs at law, was finally established by a decision of the House of Lords 25 June 1805. An act of Parliament, however, was soon after passed (39th and 40th George III, ch. xcviii), restraining the power of devising property, for the purpose of accumulation, to 21 years after the death of the testator. Thellusson's last surviving grandson died in 1856 and the final disposal of the property was not settled without an expensive and protracted lawsuit lasting until 1859; when in consequence of mismanagement and the costs of litigation the surviving heirs received but a small sum.

THEME, in music, is the subject or leading melody in a composition; in a fugue it is successively repeated or imitated in the same or in a different key by the various parts. Originally simple, themes are frequently more or less disguised by groups of ornamental notes, called variations, which serve too often merely to show off the performer's flexibility of voice or nimbleness of fingers. See MUSIC.

THEMIS, thē'mĭs, in Greek mythology, a Titaness, daughter of Uranus and Ge (Heaven and Earth); according to some, of Helios, or the Sun. Possessed of the gift of prophecy she was for a time a dweller in the oracular temple at Delphi, but she left it to become consort to Zeus. She became bv him the mother of the Hours (Horæ) and the Fates (Moiræ). The guardian of divine law and order, as established by the gods, she relentlessly pursues all who encroach on the rights of others, and her daughter Dike, the goddess of justice, is often confounded with her. She was honored at Athens, Rhamnus, Delphi and other Greek cities. In art she is pictured as a stately personality, with the cornucopiæ and scales. Consult Ahrens, 'Ueber der Göttin Themis' (1864); Harrison, J. E., 'Themis: A Study of the Social Origins of Greek Religion' (Cambridge 1912); Hirzel, R., 'Themis, Dike und Verwandtes' (Leipzig 1907).

THEMISTOCLES, thē-mĭs'tō-klēz, Greek general and statesman: b. Athens, about 514 B.C.; d. Magnesia, Asia Minor, 449 B.C. He early displayed unusual ability and great ambition. The ostracism of Aristides in 483 was in part due to his influence, and he thereupon became the political leader in Athens. He was elected archon eponymus in 481, and when the second invasion of Greece by Xerxes was threatened he obtained command of the Athenian fleet, which through his exertions had been built from the income derived from the Laurium silver mines. He consented to fight under the Spartan commander in the battle off Artemisium and when, through neglect of his advice, the pass of Thermopylæ was forced and the Persian hordes overran Bœotia and advanced upon Athens, he persuaded the Athenians to convey their women and children to places of safety, abandon the city to the Persians and those capable of bearing arms to take to the ships. The exiles, among whom was Aristides, were recalled and the command of the Greek fleet was entrusted to a Spartan, Eurybiades. The battle of Salamis (480) resulted in a signal victory for the Greeks and Themistocles, to whom the success was mainly due, now became the leader not only of Athens but of Greece. One of his greatest services to his country was the skilful manner in which, by diplomacy and artful parleying with the Spartans, he gained time for the rebuilding of the walls of Athens. From this time the glory of Themistocles declines. He had gained the hatred of the Spartans by building the walls of Athens so strongly and he was now accused by them of treasonable negotiations with the Persians. He was acquitted of this charge, though he was ostracized in 471 by his countrymen, who had become aware of his unscrupulous character and his inordinate love of riches, which he was accused of gratifying by unjust means. He retired to Argos, thence fled to Epirus, and ultimately sought protection at the Persian court, where he gained high favor with the reigning monarch, Artaxerxes Longimanus. He was deeply engaged in plans for the subjugation of Greece by the Persians, which he had promised Artaxerxes to compass, when, knowing the impossibility of fulfilling his promises, according to some accounts, he took poison; others, however, ascribe his death to natural causes. His career shows a curious admixture of noble and sagacious statesmanship and sordid ambition. He was possessed of great eloquence and was undoubtedly the savior of Athens and Greece at the crisis of Salamis. Consult Bauer, 'Themistokles' (Merseburg 1881); Grote, 'History of Greece' (1907); Wecklein, 'Ueber Themistokles' (Munich 1892); also any standard history of Greece.

THÉNARD, tā-när, **Louis Jacques**, French chemist: b. Louptiere, Champagne, 4 May 1777; d. Paris, 21 June 1857. He studied chemistry in Paris under Fourcroy and Vauquelin, becoming the assistant of the latter, who procured him a professorship at the Collège de France (1804). Subsequently he succeeded Fourcroy in the chair of chemistry at the Ecole Polytechnique, as well as in his seat in the Academy. In 1825 he was made a baron by Charles X and in 1832 a peer of France by Louis Philippe. It was while attempting to verify a theory he had propounded in the lecture-room that he made his important discovery of the peroxide of hydrogen. He worked with the chemist Gay-Lussac (q.v.), and made noteworthy original investigations, including those of the compound ethers, of bile and of sebacic acid. He discovered the method of preparation of a cheap cobalt blue, since known as «Thénard's blue.» His chief publications are a 'Treatise on Elementary Chemistry' (4 vols., 1813–16) and 'Physico-Chemical Researches' (with Gay-Lussac, 1816).

THENARDITE, a mineral identical in composition with the artificial sodium sulphate, Na_2SO_4. It is brittle, of vitreous lustre, white color, transparent to translucent, hardness 2 to 3, and specific gravity 2.68. It crystallizes in the orthorhombic system, often in tabular, cross-twinned forms, with distinct basal cleavage. It is entirely soluble in water; natural crystals speedily absorb water and effloresce. It often occurs dissolved in the waters of salt lakes, from which it is separated in crystal form during the summer season by evaporation. The most important American localities of this type are Borax Lake, California, and Rhodes Marsh, Nevada. Vast deposits exist on the Rio Verde in Arizona. It is of value in the preparation of soda.

THEOBALD, thē'ō-bâld, **Lewis**, English dramatist and Shakespearean scholar: b. Sittingbourne, Kent, 2 April 1688; d. London, 18 Sept. 1744. His classical attainments were considerable and by 1715 he had published translations of Plato's 'Phædo'; the 'Electra,' 'Ajax' and 'Œdipus Rex' of Sophocles and the 'Plutus' and 'Clouds' of Aristophanes. He made attempts at verse and tragedy, but succeeded in neither. In 1725 Pope published his edition of Shakespeare and in 1726 Theobald appeared with a work entitled 'Shakespeare Restored, or a Specimen of the many Errors as well Committed as Unamended by Mr. Pope in his late edition of this Poet: designed not only to correct the said Edition, but to restore the true Reading of Shakespeare in all the Editions ever published.' Though Pope made grudging use of the manifestly improved readings suggested by Theobald in his second edition, he never forgave the detection of his incompetence as an editor and in the first edition of the 'Dunciad' Theobald figured as hero. In 1733–34 Theobald published an edition of Shakespeare in seven volumes, in the preparation of which he had the assistance of Concanen, Thirlby and Warburton. Textual criticism of Shakespeare owes much to him, for he was the first to discard corrupted readings and in his emendations displayed knowledge, tact and good sense. Subsequent editors have depended much upon him and have adopted his corrections. At the time of his death he was engaged on an edition of the works of Beaumont and Fletcher, six plays of which he had already completed. Consult Collins, 'Essays and Studies' (London 1895); Nichols, 'Illustrations of Literature' (Vol. II, pp. 204–654).

THEOBROMA CACAO. See COCOA.

THEOBROMINE, $C_7H_8N_4O_2$, a white crystallizable alkaloid found in the chocolate prepared from the seeds of the cocoa tree. It forms salts with acids, is bitter, soluble in alcohol, slightly so in water. It is closely related to caffeine, the active principle of tea and coffee, into which it can be readily changed. Caffeine may be considered as theobromine in which one hydrogen atom has been replaced by the methyl group (CH_3). It is not used to any extent in medicine, although it has a slight sedative action on the nervous system.

THEOCRACY (from Gr. *Theos,* God, and *kratos,* power) is that government of which the chief is, or is believed to be, God himself, and the laws the commandments of God. The priests in such a government are the promulgators and expounders of the divine commands, the representatives of the invisible Ruler. The most notable theocratic government of all times was that established by Moses among the Israelites. The Puritan government of Massachusetts was also called a theocracy, owing to the claim that it was conducted on the principle of obedience to divine laws, and the requirement that all should contribute to the support of the Church and attend church services.

THEOCRITUS, thē-ŏk'rĭ-tŭs, Greek bucolic poet: b. Syracuse, according to others at Cos, and flourished about 280 B.C. He was a pupil of Philetas at Cos. Having gone to Egypt, he was treated with much distinction by Ptolemy Philadelphus, in whose praise he wrote Idyls 14, 15 and 17, but afterward returned to Syracuse, where he appears to have been on terms of some intimacy with Hiero II. We have under his name 30 idyls, or pastoral poems, of which, however, several are probably by other authors. The most doubtful are 12, 23, 26, 27, 29. He is to be considered the creator of this species of poetry as a branch of Greek literature, though the elements of it existed before his time among the Dorians both of Sicily and Greece. Most of his idyls have a dramatic form and consist of the alternate responses of musical shepherds. They present fresh and vivid pictures (εἰδύλλια, little pictures) of common life in Sicily, and are marked by considerable comic and, though to a less extent, tragic power. They are of a different sort from the affected compositions representing the «imaginary shepherds of a fictitious Arcadia.» Writing generally in the Doric, though in two cases (Idyls 28, 29) in the Æolic, dialect, which is peculiarly adapted to the simplicity of rural life, his language is strong and harmonious. His metre is chiefly the heroic hexameter. Besides the idyls he wrote a poem called 'Berenice,' of which only five lines and a word are extant, and 22 epigrams in the Greek Anthology. He was imitated by Virgil (q.v.) in the 'Eclogues'; Tennyson's indebtedness to him has been well shown by Stedman in a chapter of the 'Victorian Poets' (1876). (See THEOCRITUS, BION AND MOSCHUS, IDYLS OF). The best editions of his works (which are usually joined with those of Moschus and Bion) are those of Meineke (1856); Paley (1863); Wordsworth (new ed. 1877) and Fritzsche (3d ed. by Hiller, Leipzig 1881). There are renderings into English verse by Chapman (1866) and Calverley (Cambridge 1869) and into prose by Lang (with introduction, New York 1880). The 7th and 11th idyls are translated in verse by Leigh Hunt ('A Jar of Honey,' 1848). Consult, besides the above-mentioned works, Christ-Schmid, 'Geschichte der griechischen Litteratur' (Vol. II, 5th ed., Munich 1911); Fritzsche, 'Zu Theokrit und Virgil' (1860); Knapp, 'Theokrit und die Idyllen-Dichtung' (1882); Wright, W. C., 'A Short History of Greek Literature' (New York 1907).

THEOCRITUS, BION, AND MOSCHUS, Idyls of. Theocritus is one of the great names contributed by Greece to the literature of the world. He is the most excellent of pastoral poets, and to those later born he has always been «the glass of fashion and the mold of form»— to Bion, to Moschus, to Virgil, to the English, Italian, Spanish and French poets of the Renaissance (and there were many), who were pleased to write of shepherds, their pipes, their loves and their lamentations. His are the flowers from which all the bucolic poets of Europe have sucked their honey. He lived in Sicily in the earlier part of the 3d century B.C. An epigram, written in his name, probably by some one else, says: «I, Theocritus, who wrote these idyls, am a citizen of Syracuse, a man of the people, the son of Praxagoras and Philinna.» It also appears certain from references in his poems that he lived for a time in Alexandria, then the intellectual capital of the Hellenic world, and also on the island of Cos. Beyond this nothing is known of him.

The poems that have come down to us under his name are 32 idyls, not all complete, usually classified as bucolics, mimes, epics and lyrics and 20 odd epigrams. The term idyl comes from a Greek word which is itself a diminutive of another Greek word meaning «form» or «style,» or merely «poem,» and only a few of these idyls are what we call pastorals.

the others are little pictures or sketches on various subjects. His first idyl is a dialogue between Thyrsis and a goat herd, in which Thyrsis sings the famous 'Lament for Daphnis.' The second tells how a passionate, jilted woman attempts by magic rites to regain the love of her deserting lover. The next declares a goatherd's love for Amaryllis. Three are poetic contests between herdsmen. Two, VI and XI, are about the love of the Cyclops, Polyphemus, for the sea nymph Galatea; another is about Hercules and Hylas. Two others are eulogies on Hiero, lord of Syracuse, and on Ptolemy Philadelphus, king of Egypt. Number XIX is a very brief poem that tells how a bee stung the little god Eros; and several others are probably spurious.

Perhaps the most famous are the 1st, 2d and 15th. The first because of the 'Lament for Daphnis,' which served as a model for Bion's 'Dirge of Adonis,' for Milton's 'Lycidas,' for Shelley's 'Adonais' and Matthew Arnold's 'Thyrsis.' The second, in the opinion of Sir Gilbert Murray, is «realistic, beautiful, tragic, strangely humorous and utterly unforgettable, and has remained a unique masterpiece in literature.» The 15th is probably the most interesting to English readers; it is certainly the most entertaining. Matthew Arnold calls it «one of the best and happiest of Theocritus's idyls.» It is really a little play, of which the two chief dramatis personæ are Syracusan women, living in Alexandria. One comes to get the other to go with her to a notable religious celebration in honor of Adonis, which the queen of Egypt has arranged with unusual magnificence. The celebration is to be in the palace, where a beautiful picture of Adonis is to be exhibited and a famous prima donna is to sing a hymn to Aphrodite and Adonis. The two women and their maids make their way through the crowded streets, squeeze into the palace with difficulty and hear the hymn. The scene is most lifelike.

And it is mainly this quality of lifelikeness that, in the bucolic idyls, distinguishes Theocritus from Virgil and all his other imitators. We need not suppose that Sicilian shepherds really spoke as Thyrsis and Daphnis speak, or even like the less elegant Battus and Corydon. But Theocritus uses language not too far from truth and depicts the Sicilian country, with its flowers and rustic objects, in a realistic way; whereas his imitators are all artificial, and many, especially during the Renaissance, ridiculously so forsaking all semblance of reality. The scenes in which their Phyllises and Corydons make love or lamentation might well be in Marie Antoinette's drawing room; but his shepherds drive their flocks afield in the meadows near Girgenti, or over the plains of Catania.

No translation of Theocritus can give more than a rude idea of the original. Strictly speaking, poetry cannot be translated; and in a translation of Theocritus not only is the music gone, but his words are so accurately chosen that the foreign equivalents are merely makeshifts. For English readers perhaps the best translation of the 15th idyl is that in Matthew Arnold's essay on 'Pagan and Mediæval Religious Sentiment,' and for the other idyls, the prose versions by Andrew Lang. Edmund Clarance Stedman translated four, the I, X, XIII and XIX, following the hexameters of the originals. Many other translators in prose and verse have tried their hands, and some with a reasonable measure of success.

Bion is an imitator of Theocritus. Little that he wrote remains: there is the 'Dirge of Adonis,' half a dozen short idyls and some fragments; he himself is a shadow. From the poem, a 'Lament for Bion,' attributed to Moschus, it appears that Bion was born in Asia Minor near Smyrna, and possibly that he traveled in Thrace and Macedonia, also that he lived in Sicily and died by poisoning, and that Theocritus mourned him. But modern criticism denies that the 'Lament' was written by Moschus, denies the story of poisoning, and puts Bion about 150 B.C. The 'Dirge of Adonis' is by far the most celebrated of his poems; for if the earliest suggestion for 'Lycidas,' 'Adonais' and 'Thyrsis' comes from the 'Lament for Daphnis,' it certainly comes by way of the 'Dirge of Adonis.' The poem is a lament by Aphrodite over the dead Adonis; in part it is passionate to frenzy, with an element of Asiatic extravagance, but in other parts florid, pretty, elegant and artificial. His other poems, for the most part, are love songs, delicate, sweet and elegant.

Moschus seems more shadowy still. His fame is united to that of Theocritus and Bion, as one of the three chief pastoral poets of Sicily; and this union in renown has been strengthened by the common practice of publishing their works together. To Moschus were usually attributed six or seven idyls, 'Eros,' 'The Runaway,' 'Europa,' the 'Lament for Bion,' 'Megara, the Wife of Hercules,' and others. The 'Lament for Bion' is the poem on which his fame has chiefly rested. It represents the poet as Bion's pupil, and is framed upon the models of the 'Lament for Daphnis' and the 'Dirge of Adonis,' it is pathetic, delicate and imaginative. But the style is too ornate to befit a contemporary of Theocritus, and seems to prove that the poem belongs to a later age. Modern criticism, therefore, takes away its authorship from Moschus and that of the *Megara* as well. Moschus himself is now believed to have lived at Syracuse about 150 B.C. The authoritative text of 'Bion and Moschus' is that by U. von Wilamowitz-Möllendorff, 'Scriptorum Classicorum Bibliotheca' (Oxford 1905).

No translation of any of these poems gives more than a rough and ready idea of the original. The more imaginative the poet, the more delicate his workmanship, the less the translator can imitate him. This is as true of Bion and Moschus, or whoever wrote the 'Lament for Bion,' as it is of Theocritus.

HENRY D. SEDGWICK,
Author 'Essays on Great Writers,' etc.

THEODICY, a term of Leibnitzian philosophy, in which the existence of physical and moral evil is made reconcilable with the existence of a righteous God, the controlling providence of the best of possible worlds. See LEIBNITZ.

THEODOLITE. See SURVEYING.

THEODORA, thē-ō-dō'rạ, Byzantine empress consort of Justinian I: b. 508 A.D.; d. 548. She was, according to the dubious evidence of Procopius, the daughter of Acacius, a bear-ward at Constantinople, and had already been by turns actress, dancer and harlot, when she won the heart of the austere and ambitious Justinian, to become in succession his mistress, his wife and the sharer of his throne (527). Never thereafter did the breath of scandal touch her name; she became Justinian's trustiest counsellor, bore a chief share in the work of government, and saved the throne by her high courage at the crisis of the Nika riots (532). «Now every man must die once,» said she in council, «and for a king death is better than dethronement and exile. . . . If you wish, O emperor, to save your life, nothing is easier; there are your ships and the sea. But I agree with the old saying that 'empire is the best winding-sheet.'» She lavished her bounty on the poor. Consult Débidour, Antonin, 'L'Impératrice Theodora' (Paris 1885); Diehl, Charles, 'Justinien et la civilization byzantine au sixième siècle' (Paris 1901); id., 'Théodora, impératrice de Byzance' (3d ed., Paris 1904); Gibbon, Edward, 'Decline and Fall of the Roman Empire' (ed. by J. B. Bury, Vols. IV and V, 1912); Mallet, C. E., 'The Empress Theodore' (in *English Historical Review*, Vol. II, London 1886).

THEODORE I, thē'ō-dōr, of Corsica, otherwise Baron Theodore de Neuhoff, German adventurer: b. Metz, about 1686; d. London, 11 Dec. 1756. He was the son of a Westphalian nobleman and engaged in the French, Swedish and Spanish service successively. In 1732 he went to Florence as chargé-d'affaires for Emperor Charles VI, and taking part in a Corsican uprising against Genoa through funds furnished by the Bey of Tunis, was proclaimed king of Corsica in 1736. Soon after, however, he was driven to flight, but made two subsequent attempts to reinstate himself in 1738 and in 1743. In 1749 he settled in London, where his creditors put him in prison; but his release was gained through the support of Walpole. By his wife, an Irish lady whom he robbed and deserted, he had one son known later as Colonel Frederick, author of 'Memoires pour servir à l'historic de Corse' (1768) Consult Fitzgerald, 'King Theodore of Corsica' (London 1890).

THEODORE II, or NEGUS, king of Abyssinia: b. province of Kwara, 1818; d. Magdala, 14 April 1868. Originally named Kasa or Kassai, he led a revolt in 1854 against Ras Ali, ruler of Abyssinia, whom he defeated. Later he was crowned, under the title of Theodorus, king of kings, of Ethiopia. He was a man of strong personality, an enemy of Islamism, a ruler and a reformer. He became intolerant of any power other than his own and with the quick suspicions of a barbarian took offense at what he considered as slights. His quarrel with Great Britain was brought on by the injudicious conduct of the English consul, Captain Cameron, sent to him in 1861 and by the failure of the English government to respond to his overtures regarding the reception of his Ambassador at the English court. He finally imprisoned Cameron and also Hormuzd Rassam, a Turk but an English subject, sent to treat with him concerning Cameron's release. As a condition of setting the prisoners at liberty Theodore requested that certain skilled artisans be sent him, together with presents that he had been led to expect. The English detained the artisans and presents at Massowah, awaiting the release of the prisoners; but as they were not delivered up, war was declared, and an expedition under Sir Robert Napier began a progress toward Magdala in the latter part of 1867. The city was reached, and active hostilities began on 10 April 1868. On the 14th the city was taken and Theodore was found dead. The besiegers were informed that he had committed suicide. See ABYSSINIA and consult *Westminster Review*, New Series, No. 65.

THEODORE OF MOPSUESTIA, Greek ecclesiastical writer: b. Antioch, about 350; d. 428. He studied rhetoric under Libanius, philosophy under Andragathus and sacred literature under Flavianus of Antioch, Diodorus of Tarsus and others. Early in life he followed the example of his fellow-student and intimate friend, John Chrysostom, in turning monk, although he had been on the point of marrying a lady of Antioch named Hermione. After being ordained priest he distinguished himself as an opponent of Arius Apollinaris and others. From Antioch he removed to Tarsus and in 392 was chosen bishop of Mopsuestia in Cilicia. In 394 he preached before the Emperor Theodosius at Constantinople and was present at the council held in that city at that date. He was a voluminous writer, the most important of his works being commentaries on the Bible and polemical treatises. These were held in great repute among the Syrian churches and many of them were translated into Syriac, Arabic and Persian. His views approximated to those of Pelagius, and Nestorius was to be his disciple. In the Eastern Church, accordingly, he was condemned as a heretic at the Fifth Ecumenical Council, held at Constantinople 553. For fragments of Theodore's works consult Migne, 'Patrologia Græca' (Vol. LXVI. Consult also Harnack, A., 'History of Dogma' (Vols. III, IV; Boston 1898); Kihn, H., 'Theodore von Mopsuestia' (Freiburg 1880); Wace and Piercy (eds.), 'Smith's Dictionary of Christian Biography' (Boston 1911); Wright, W., 'Syriac Literature' (London 1894).

THEODORET, thē-ŏd'ō-rĕt (Greek, Θεοδώρητος), church historian and theological writer: b. Antioch, late in the 4th century; d. 457. He was educated in a monastery near Antioch, where he had Nestorius and John of Antioch for fellow-pupils. After 25 years' study and retirement he succeeded Isidorus (423) as bishop of Cyrus, a city about two days' journey from Antioch. He endeavored to play the part of mediator between Nestorius and Cyril of Alexandria, but could effect no reconciliation. In 431 Nestorius was deposed by the Council of Ephesus, an act which Theodoret at first protested against, but later on excused. When the Nestorians were prosecuted with relentless severity, he stood forth as the champion of Nestorius against Cyril and his successor Dioscurus. The latter accused Theodoret of Nestorianism, pronounced a public anathema upon him in the church of Alexandria and (449) procured his deposition at the so-called robber council of Ephesus, a sentence which was reversed by the general council of Chalcedon (451). The most important of his works, of which a complete edition was published by Schulze and Nösselt (1769–74), consist of commentaries on the Old Testament and on the Pauline epistles; 'Ecclesiastical History,' in five books, beginning with the history of Arianism under Constantine the Great and ending with the death of Theodore of Mopsuestia; 'Religious History,' a narrative of the lives of the hermits, called the Fathers of the Desert; 'Eranistes,' three dialogues against the Eutychians, and 'History of Heresies.' Consult Binder 'Études sur Théodoret' (Geneva 1844); 'Gaisford, 'Theodoreti Historia Ecclesiastica' (1854); Harnack, A., 'History of Dogma' (Vol. IV, Boston 1898); 'The Nicene Fathers' (ed. by Schaff and Wace, Vol. III, New York 1892).

THEODORIC I, thē-ŏd'ō-rĭk, king of the Visigoths. He was chosen successor to Wallia about 419 A.D., and became desirous of extending his kingdom, especially so as to embrace the neighboring Roman cities of Arles and Narbonne. For this purpose he made war against the Romans after the death of Honorius in 423 and continued with varying results until 437, when he entered into an alliance whose exact terms are unknown. By 450 he came into closer alliance with the Romans in the endeavor to check the advance of Attila, who led his barbarian army across Lorraine and Champagne and captured the city of Orléans. Theodoric and Aëtius, the Roman general, encountered Attila near the village of Moirey, a few miles from Troyes, and fought the battle generally known in history as that of Châlons-sur-Marne, in 451. Theodoric was killed by an arrow; but the progress of Attila was checked and western Europe was saved from the domination of barbarism.

THEODORIC II, son of Theodoric I. He was a member of the party who wished to remain on terms of peace with Rome and when his brother, Thorismund, who had succeeded Theodoric I, began to levy war against the Romans he took part in a rebellion that ended in the murder of Thorismund and his own elevation to the throne. As vassal of the Roman emperor Avitus he made an expedition against the Sueves, conquered and put to death their king and was in a fair way of completing the conquest of Spain, when Avitus was deposed and killed and Theodoric ceased his efforts. In 466 he was murdered by his younger brother, Euric.

THEODORIC THE GREAT, king of the Ostrogoths: b. about 454; d. 526. His father, Theodemer, was one of the three brothers who jointly ruled the Ostrogoths settled in Pannonia, and he sent him, when only eight years of age, to Constantinople as a hostage, to secure the conditions of a treaty between the Goths and the Emperor Leo. After residing 10 years with that emperor he was restored to his father, then sole monarch of the Ostrogoths. On the death of Theodemer, about 474, he succeeded to the crown and began a course which, after menacing the safety of the Greek empire, and Constantinople itself, terminated in an expedition against Odoacer, who had assumed the title of king of Italy. After several bloody engagements the latter was finally induced to yield, on condition that he and Theodoric should govern Italy with equal authority (493). The murder of Odoacer at a banquet soon followed this agreement; on which Theodoric caused himself to be proclaimed king of Italy, and he governed with extraordinary vigor and ability. He attached his soldiers by assigning them a third part of the lands of Italy, on the tenure of military service; among his Italian subjects he encouraged industry and the arts of peace. He improved the administration of justice, issued edicts to protect the public monuments at Rome and elsewhere, and assigned revenues for the repair of the public edifices. Like his ancestors he was an Arian, but was indifferent to controversy and never violated the peace or privileges of the Roman Catholic Church. The particulars of the government of this memorable prince, who shed a short-lived lustre on the Gothic name, are recorded in 12 books by his secretary, the senator Cassiodorus, a man of learning, who induced his illiterate master to become a patron of letters. The senators Boethius and Symmachus were both put to death on the mere suspicion of an intrigue between a senatorial party and the imperial court. This cruel act had no sooner been perpetrated than Theodoric was seized with remorse, and a fever ensued, which terminated his life in three days. The ordinary residence of this king was at Ravenna, above which city his daughter Amalasuntha erected a splendid monument to his memory. Consult Dahn, Felix, 'Die Könige der Germanen' (Vol. III, Würzburg 1866); Gibbon, Edward, 'Decline and Fall of the Roman Empire' (Vol. IV, ed. by J. B. Bury, London 1912); Hodgkin, Thomas, 'Ostrogothic Invasion' (in 'Italy and Her Invaders,' Vol. III, London 1885); id., 'Theodoric the Goth' (New York 1893).

THEODOSIA. See FEODOSIA.

THEODOSIUS (thē-ō-dō'shĭ-ŭs) **THE ELDER,** Roman general: d. Carthage, 376. He was the father of the Emperor Theodosius I (q.v.), called «The Great.» By birth a Spaniard, he rose to high rank in the Roman army and in 367 was sent by Valentinian I to Britain, where he repelled the invasions of the Picts and Scots, strengthened the military defenses and restored order. He formed the country between Hadrian's wall and the Forth and Clyde into a new province, which he named Valentia, and then returned to Rome. He was later stationed on the Upper Danube, where he was victorious over the Alemanni, and in 372 he quelled the revolt in Africa led by the formidable Moorish chieftain Firmus. He was beheaded at Carthage in 376 by order of Valens, on some unknown and probably unjust charge.

THEODOSIUS (surnamed THE GREAT), Roman emperor: b. Spain, about 346; d. Milan, 17 Jan. 395. At a very early age he obtained a separate command; but on the execution of his father he sought retirement, until selected by the Emperor Gratian, in 379, for his partner in the empire. To his care were submitted Thrace and the eastern provinces, which he delivered from an invasion of the Goths, whom he signally defeated in two battles, concluding a peace with them in 382. On the defeat and death of Maximus at Aquileia (388) he became the sole head of the empire, Gratian having been previously killed in the war against Maximus. He administered the affairs of the West in the name of Valentinian, the son of Gratian, then a minor. He entered Rome in triumph in 389, and passed three years in Italy. In 390 a sedition took place in Thessalonica, which resulted in the murder of the governor and several of his officers. The resentment of Theodosius was natural and merited; but the manner in which he displayed it was in the highest degree detestable and inhuman. An invitation was given in the emperor's name to the people of Thessalonica to an exhibition at the circus, and when a great concourse of spectators had assembled they were massacred by a body of barbarian soldiery to the number, according to the lowest computation, of 7,000. Theodosius was at this time at Milan, of which Saint Ambrose was bishop, and this prelate, on account of such an atrocious proceeding, resolutely refused him communion for eight months. About this time the emperor crowned his merits, as a foe to paganism, by demolishing the celebrated temple of Serapis and all the other heathen temples of Egypt, and he issued a final edict prohibiting the ancient worship altogether. On the murder of Valentinian by Arbogastes and the advancement of Eugenius in his place (392), the emperor carried on a war against the latter, which finally terminated in his defeat and death. Theodosius did not long survive this success. Consult Gibbon, 'Decline and Fall of the Roman Empire' (London 1912); Hodgkin, T., 'Italy and her Invaders' (Oxford 1892).

THEODOSIUS II, Roman emperor, son of Arcadius and grandson of Theodosius I: b. 401; d. 450. He became emperor in 408, but proved a weak ruler, and the actual government was in the hands of his sister and of his wife during the greater part of his reign, in which the Theodosian code of laws was compiled. He was killed by a fall from his horse and was succeeded by his sister, Pulcheria.

THEODOSIUS III, emperor of Constantinople. He held the unimportant post of collector of the revenue when he was nominated to succeed Anastasius, and he was crowned in 716. He resigned in favor of Leo the Isaurian in 717 and retired to a monastery. Consult Gibbon, E., 'Decline and Fall of the Roman Empire' and 'Cambridge Mediæval History' (Vol. I, New York 1911).

THEOGNIS (thē-ŏg'nĭs) **OF MEGARA,** Greek elegiac poet. He lived between 540 and 500 B.C. There are 1,389 verses preserved under his name, of importance in enabling us to understand the state of parties and the problems of society in the Greece of that time. They were translated by Frere (1842) and are found in the original in Bergk's 'Poetæ Lyrici Græci.'

THEOGONY, a poem treating of the generation and descent of the gods. The most ancient Greek theogony known to us is that of Hesiod, the earlier Theogonies of Musæus and Orpheus having perished.

THEOLOGICAL DETERMINISM. See DETERMINISM.

THEOLOGICAL EDUCATION. See EDUCATION, THEOLOGICAL.

THEOLOGICAL SEMINARY OF THE REFORMED CHURCH OF AMERICA, New Brunswick, N. J., originally located in New York City from its organization (1784), afterward at Flatbush, L. I. (1796), was established on the present site in 1810. The general Synod conducts it and it now has an endowment of nearly $1,000,000. Its buildings include the Peter Herzog Hall for dormitory purposes; the James Suydam Hall, used for lecture rooms, gymnasium and museum, and the Gardner A. Sage Library which contains nearly 60,000 volumes. There also are several buildings for the teaching force.

THEOLOGY, the science of religion. This term, together with the corresponding personal term, antedates the Christian era, having been used by classic writers both Greek and Roman. In the view of Aristotle, Cicero and others the man who appeared to be specially conversant with the divine nature was fitly called a theologian. Among those honored with this name were Pherecydes of Syros and Epimenides of Crete.

Definition and Scope.— In the modern use of the term a narrower and a broader signification may be distinguished. The former, paying special respect to the etymology of the word, includes in theology simply discourse about God. It was in this restricted sense that the word was employed by the classic writers and a corresponding usage had place in the first Christian age, when, for example, the evangelist, John, on the ground of his relatively full reference to the divinity of the Christ, was called «the theologian.» It was understood that the subject matter of theology pertains to such transcendent themes as the Logos and the Trinity. In the broader signification theology includes not only discourse about God, but also an exposition of whatever in man's nature seems to bring him into distinct relation with God; likewise an exposition of whatever in man's experience and destiny may be regarded as founded on this relation. In this sense it is the theoretical counterpart of religion, and corresponds very well to the following description by Gladstone: «Theology is ordered knowledge, representing in the region of the intellect what religion represents in the heart and life of man.» While resort is still occasionally made to the restricted sense, as when, for instance, theology is put in antithesis with anthropology, the broader signification is far more commonly the one intended in current usage. It is evidently, therefore, the signification which should give the standard for the present discussion.

In a precise determination of the scope of theology a question will arise, in the first place, as to the measure of consideration which it is appropriate to bestow upon the ethnic religions. Manifestly, if theology is the theoretical counterpart of religion, it will not do to neglect so large an area of religious facts as is included in the ethnic systems. A secure and well-rounded theory of religion must take account of all accessible religious facts, whether inside or outside of the pale of historical Christianity. At the same time it is to be noticed that the central tenets of Christianity, as they appear in the sacred oracles and have generally been held, unmistakably presume upon the pre-eminence and finality of the Christian religion. Anyone, therefore, who regards himself as scientifically obligated to accept these tenets, on the score of a clear preponderance of evidence in their behalf, will of necessity be convinced that he fulfils the demands of a scientific theology in taking subordinate account of the ethnic systems, that is, so far as respects formal recognition of them within his own theological structure. It is not needful, indeed, that he should deal with these systems in a tone of radical disparagement. As a matter of fact, the industrious research which for the last quarter of a century or more has been bestowed upon the great ethnic religions, such as Zoroastrianism, Buddhism, Brahmanism and Confucianism, has served distinctly to enlarge appreciation for their contents. At the same time, the farther this research has proceeded the more indubitable has it made the proof that Christianity has no occasion to look to any outside religious province for an appreciable supplement to its teachings. The conclusion follows that the Christian theologian deals normally with the ethnic systems when he simply accords to them a place in branches auxiliary to some of the main divisions of theology. In so far as they have modified Christian history they make matter for a branch auxiliary to historical theology. In so far as they supply data for a philosophy of religion they help to constitute a branch auxiliary to systematic theology.

A second important question under the theme of scope or province concerns the relation of theology to philosophy. That the one is under practical compulsion to enter the domain of the other is apparent upon both rational and historical grounds. Their tasks are closely related. Philosophy may be defined as an attempt to get at ultimate truth by rational processes. Theology attempts, within limits, the same thing. It undertakes to get at ultimate truth in so far as that truth has religious worth or significance. Theology may enter upon its task with a more positive presumption in favor of written revelation than that which belongs to the philosophical starting-point. Still, if it is to maintain a scientific character, it cannot take that presumption as a mere matter of course. On the contrary, it must treat the same as a subject for searching inspection. Now this inspection will naturally lead sooner or later to the great problem of the conditions of rational certainty. Thus the initial task of theology in approving or rating the authority of sacred oracles conducts into a province of philosophical inquiry. And what occurs at this point is repeated at various other points. The development of the deeper themes of theology involves in general a use of philosophical premises, either metaphysical, psychological or ethical. A veto against such use is impotent. A Tertullian may exclaim, "What has Athens to do with Jerusalem? What concord is there between the Academy and the Church?" But before the echo of his voice has died away he will be likely to get onto the ground of Athens, and to be borrowing from the Academy or some kindred source. From beginning to end Christian history testifies to the tendency of theological construction to utilize philosophical points of view. Among the early Fathers the more speculative were manifestly influenced by the Platonic philosophy. A little later the Neo-Platonic philosophy became an appreciable factor in theological thinking, and through the writings of the pseudo-Dionysius was introduced to the thinkers of the mediæval period. At the crowning period of mediæval scholasticism Aristotelianism was decidedly in the ascendant, insomuch that Aristotle was often cited under the simple designation of "the philosopher." In the modern period the Cartesian philosophy, the Leibnitz-Wolffian, the Lockian, the Kantian, the Hegelian and others have unmistakably claimed spheres of influence in the theological domain. It appears, therefore, that a discreet choice of philosophical affiliations is the best that theology can do. It may enter into too close an alliance with a specific philosophy. It may fail to observe the due balance between a speculative bent and a sane regard for historical data. But it will and must draw largely from the resources of philosophy if it is to be fundamental and comprehensive.

A further question on the scope of theology concerns the relation of this branch to the domain of natural science. That a relation obtains to which a measure of significance may be attached is undeniable. It is not to be overlooked, however, that the field of natural science comes into less extensive contact with theology than does the field of philosophy. In so far as science moves in a physical or sub-human range, it touches upon matters that are of only subordinate theological import. It may enforce a revision of the theory of creation which has been read into or elicited from the biblical narrative; but of how small theological consequence is a conclusion on the precise method of creation, so long as God in his absolute supremacy and man in his dignity and worth are left to the contemplation! It may enlarge the view of the operation of secondary causes in the production of organic forms, and so may require some modification of the putting of the argument from design; but that involves no challenge to any theological tenet or interest, since the vast range of orderly results in nature must still be seen, as many of the most eminent naturalists confess, to demand ultimately an ordering intelligence. In short a close scrutiny of the subject will reveal that the findings of the physical sciences can neither displace the foundations of the central tenets of theology nor supply foundations to these tenets. Their function is exhausted in modifying one and another peripheral matter or adjunct of the theological system. Probably the greatest result which has come from that quarter is an offspring of the doctrine of evolution and consists in an enlarged tendency of the theological mind to expect, in relation to the kingdom of God in the world, tokens of the law of consecution and graduated progress. Undoubtedly the theologian does well to take note of the approved findings of natural science; but large expectations of contributions from that quarter are not likely to be fulfilled. It is in the constitution and experiences of man, and in the philosophical interpretation of both the world of nature and of personality, that theology must find its principal basis. Among the human experiences that come into the account those which make up the substance of sacred history may of course claim a distinct primacy. In other words, the Bible may be rated as the foremost treasury of theological data.

Scientific Value and Rank.— One and another system of theology, as actually developed, may be remote from a scientific character. But intrinsically scientific construction is just as feasible and appropriate in the field of theology as in any other field. Where a contrary impression has obtained it has generally been due to one of three causes. Either the agnostic maxim that religion has the unknown for its proper field has been adopted, and in consequence theology, as the theoretical side of religion, has been pictured as devoid of substantial foundation; or theology has been associated with arbitrary authority; or a strained antithesis between reason and faith has been contemplated.

As respects the maxim which embodies the first of these grounds of objection, it must be pronounced a gratuitous negation of religion. It is a negation of religion, for sheer mystery offers no means of attachment. In the words of Pfleiderer, «a religion of nothing but mystery is an absurdity.» The maxim is also perfectly gratuitous. As John Fiske has said: «None can deny that religion is the largest and most ubiquitous fact connected with the existence of mankind upon earth.» Is so vast a department of human experience to be regarded as utterly incompetent to supply any valid grounds of induction? Are the concurring thoughts, aspirations and satisfactions of the elect spirits of the race to be rated as void of all rational suggestions? Is no sure basis of conviction to be found in the illuminated and transcendent consciousness of the Christ? Such questions need no formal reply. Theology doubtless has a great border-land of mystery. And so has biology. Indeed it is characteristic of most of the sciences that they impinge upon mystery. Alongside a domain of certainty they include areas which can claim at best only a high degree of probability. On the score of mystery, therefore, no good reason is apparent for expelling theology from scientific fellowship.

The second ground of objection of the scientific character of theology is sufficiently met by the affirmation that arbitrary authority is an interloper in the theological domain. If it has ever installed itself there, it has been in the exercise of rank usurpation. Theology in its true character has no partnership with arbitrary authority. While it may make large account of positive revelation, it does not turn that revelation into a fence against investigation but uses its content for what it proves itself to be under the tests of mental scrutiny and prolonged application to the exigencies of man's deeper life.

To the third objection a reply of similar tenor is to be made. The assumption of an antagonism between reason and faith, and of an obligation to sacrifice the former to the latter, is an assumption which a sane theology must emphatically repudiate. It is very true, doubtless, that reason cannot take the place of faith any more than theory can take the place of action. But it is equally true that faith cannot endure to be in known antagonism to reason. An assent which, from the standpoint of the one rendering the same, does not appear to be sanctioned by reason, is no real assent. Only that which is competent to take captive man's rational personality is able to induce a faith that is anything more than a sham or a shadow. Quite as much as any other branch of learning theology is free to emphasize the demand for rationality in faith. The challenge to its scientific character is thus seen to fail as respects each of the cardinal objections mentioned.

In an unbiased valuation of theology too rigid an association will not be made between substance and form. Integrity of substance is compatible with a variety of forms. Theology in no wise rebels against a poetic garb. Far as are the picturesque discourses of Jesus from the scholastic form, they are deeply based in theology. Filling all their background is one of the most pronounced conceptions of God, as well as the most beautiful that was ever set before the contemplation of men. All religious discourse which is to avoid the charge of emptiness and impotency must in like manner enclose a substantial theological content. As Phillips Brooks has said, «No exhortation to a good life, that does not put behind it some truth as deep as eternity, can seize and hold the conscience.»

Even in its formal character theology may be rated as second in interest to no department of thought and study. The facts and truths with which it more directly deals are the deepest in man's being and the highest above the human plane. It utilizes the most significant findings of a large proportion of the branches of learning. It takes into consideration the greatest treasures of past history, and gathers up the data for the farthest possible outlook into future destiny. It gives ample room for speculative acumen, but at the same time includes the themes that are of all the most intensely practical.

The Organic Arrangement of Subject Matter.— The best arrangement of the several divisions and branches of theology is obviously the one which is characterized by simplicity as well as by comprehensiveness and self-consistency. The very subtle scheme is likely to please its inventor in a much higher degree than the theological world at large. Among plans of arrangement which meet in good measure the combined demands of simplicity and comprehensiveness those of Heinrici and Hagenbach are worthy of special mention. The former draws a distinction between «historical» and «normative» branches, the one being made to include the specifically biblical branches as well as the history of Christianity since biblical times, and the other comprising, as principal subdivisions, Systematic Theology and Practical Theology. The idea of the historical branches is to exhibit the whole deposit of religious truth and fact; the idea of the normative branches is to afford means of guidance in religious teaching and work. That there is a certain fitness in the distinction between the two lines of study is undeniable. Still the distinction is not beyond criticism. One who accredits a high degree of authority to the Bible may well be reluctant to exclude the designation of «normative» from one and another biblical branch. Especially may he hesitate to exclude that designation from Biblical Dogmatics. In view of this ground of exception to Heinrici's nomenclature the plan of Hagenbach — which divides the whole theological domain between Exegetical, Historical, Systematic and Practical Theology — may be regarded as having at least an equal claim to appreciation. Aside from its intrinsic merits, a motive for giving this plan the preferred place in the present connection is found in the fact that it is very largely reflected in the curricula of theological institutions.

Each of the divisions in the fourfold scheme of Hagenbach contains a somewhat indeterminate number of specific branches. A measurably complete list for Exegetical Theology may be given as follows: (1) Biblical Philology or Linguistics, which treats not only of the biblical languages, but also of languages so far cognate with the biblical as to be able to furnish means of understanding the peculiarities of the latter. (2) Biblical Archæology or the science of Biblical Antiquities. (3) Canonics, or the branch which gives the history of the canon, or collection of sacred books, and also the principles which enter into the determination of the proper compass of that collection. (4) Biblical Criticism, which in one division is textual, and in another literary and historical. The former seeks to ascertain the true and original text; the latter is occupied with the investigation of the biblical books for the purpose of ascertaining their authorship, their date, their relation to other writings, canonical or uncanonical, the degree of their historical trustworthiness and the special stage which any one of them may represent in the development of the biblical religion. The two forms of criticism are frequently distinguished as the Lower and the Higher. (5) Biblical Introduction, in which the fruits of criticism are utilized for a more or less detailed characterization of each of the two Testaments and also of the individual books which they contain. (6) Hermeneutics, or the science of biblical interpretation. (7) Exegesis, or the presentation in detail of the results of an examination into the meaning of biblical texts.

Historical Theology includes in its biblical part the following divisions: (1) Old Testament History; (2) the Life of Christ; (3) the History of the Apostolic Age; (4) Biblical Theology of the Old Testament; (5) Biblical Theology of the New Testament. Etymologically considered Biblical Theology might denote other than a historical branch, being taken as the equivalent of Biblical Dogmatics. But as actually treated it is a historical discipline, its object being to set forth the genesis of doctrine and its movements through the various stages which may be discerned in the Old and the New Testament respectively. In its post-biblical part Historical Theology falls into two main divisions, General Church History, and the History of Christian Doctrine. The former admits of a great number of subdivisions, it being possible to award a monographic treatment to such themes as missions, polity, discipline, worship, and art. In its earlier section General Church History includes in particular Patristics and Christian Archæology, of which the former gives an account of the lives and writings of the fathers (usually of the first six centuries), and the latter furnishes a systematic presentation of monumental and documentary evidence on the art, institutions, rites, customs and characteristic modes of thought and feeling in the early Christian community. To the History of Doctrine the most important subsidiary branch is Symbolics, or that which treats of the creeds. As an auxiliary branch the History of Philosophy takes the first rank.

Systematic Theology, which has, in its Christian character, the office of furnishing an orderly presentation and justification of the whole body of teachings or beliefs which belong to the Christian religion, includes three principal branches, namely, Apologetics, Christian Dogmatics and Christian Ethics. It may also include Biblical Dogmatics, Polemics and Irenics, though the subject matter covered by these titles can conveniently be appropriated within other branches. An auxiliary to Systematic Theology of special significance is found in the Philosophy of Religion. Of the several branches named, Christian Dogmatics is so far central and prominent as often to be styled Systematic Theology. Being free to gather its evidence from every field, and aiming to present in organic form the whole doctrinal content of the true religion, it commands in the field of theology the maximum intellectual interest.

In Practical Theology the leading branches are Liturgics, Homiletics and Pastoral Theology. The last-named is of wide compass, including besides the general theme of pastoral care such subsidiary branches as Catechetics, Ecclesiastical Polity, Ecclesiastical Discipline, and Theory of Missionary Work. Recently the interest in sociological study has created a motive to subjoin a branch which might be entitled Christian Sociology.

Prominent Stages and Representatives.— In the broad view three great epochs in the progress of theology are distinguishable, namely, the Greek, the Latin and the Modern. The last might also be called with relative propriety the Protestant, since the motive-power for its developments has been supplied in large part from within the domain which bears that title. The development of the Latin type was in part contemporary with the shaping and manifestation of the Greek type; still the former appears clearly second in order, since its initial stages were synchronous with the culminating stages of the latter. Greek theology had run its course and come essentially to a standstill before the more characteristic systems of Latin theology were elaborated by the mediæval scholastics. The two undoubtedly had very much in common. The same great creeds were acknowledged in the Latin as obtained in the Greek division of Christendom, and the dogmatic grounds which were alleged ultimately for the severance of fellowship were of subordinate import. Still Greek theology stood in measurable contrast with Latin. It took on the whole a more genial view of the divine relation to the non-Christian world. It was less inclined to a sombre conception of man's native guilt and moral impotency. It accentuated to a special degree the thought of a divine incarnation and of the intimate connection between God and man provided for by means of the incarnation. The same thought was by no means foreign to Latin theology, but in its domain it was given, relatively speaking, less prominence, since it was made to share the field with the greatly emphasized conception of divine rulership. The standpoint of the one affiliated with a mystical theory of an interior life; the standpoint of the other was more legal and governmental. Both admitted the ideas of priestly mediation and sacramental efficacy, at least after the initial stage; but it accorded with the genius of Latin theology to work out the most consummate expression of these ideas in a thoroughly elaborated hierarchical and sacramental system. In the one authority came to be regarded as specially resident in the creeds and formularies of the past, in the other great prominence came to be assigned to the hierarchy, and especially to its head, as the perpetual embodiment of infallible authority. While this line of contrasts may legitimately be affirmed, it is to be understood that one and another point of difference cannot be taken too strictly, since in neither the Latin nor the Greek domain was theological thinking entirely uniform or homogeneous.

The Protestant era was initiated in a revision of the principle of authority which had been transmitted in Latin Christianity; and a fundamental feature of the theological activity of that era has consisted in carrying out this revision to its logical results. Original Protestantism accepted in common with the Latin communion the great outlines of doctrine contained in the ancient creeds, especially the Nicene and the Chalcedonian. But it accepted them upon a revised basis. What was that basis? In the last analysis it must be defined as the principle of free rational induction, in opposition to the principle of judicial determination by official authority. The primary appeal was indeed to the scriptural content and to the doctrine of justification by faith. But since no infallible tribunal was set over the Scriptures, the appeal thereto amounted practically to a transference of the main emphasis to the free rational process. As respects the doctrine of justification by faith, it looked evidently in the same direction, since it profoundly qualified the necessity of priestly mediation or of dependence upon the hierarchy. The assertion of this revised conception of authority, it is needless to say, was not designed to imply any challenge to the idea of supernatural revelation. Logically, too, the Protestant principle involves no necessity to challenge that idea. What it shuts out is official monopoly of revelation and authoritative determination of its import by official prerogative. In place of this it installs, as the proper ground of theological convictions, free rational induction, an induction which, to be properly carried out, must take full account of the data of history, reason and experience. The advocates of the Protestant principle admit the great difficulty of the task of ideal theological construction on the basis of that principle; but it is their conviction that exemption from the labor of a thorough-going induction ought not to be sought in the religious sphere any more than in other spheres. The seeking of relief in the attachment of infallible authority to some perpetual office in the Church they regard as quite useless and mistaken, since it is less difficult to accredit, on the basis of history, reason and experience, any worthy element of belief, than it is to prove the continuous existence of an infallible tribunal.

In a closer review of the progress of theology it would be necessary to notice a number of significant developments in each of the great epochs mentioned. Account would need to be taken of the peculiarities of the early Alexandrian, the Cappadocian, the later Alexandrian and the Antiochian schools in the Greek Church. In relation to the Latin Church attention would need to be given to the long history of the antithesis between Augustinian and anti-Augustinian tendencies; to the struggle between Jansenism and Jesuitism; to the conflict between Gallicanism and Ultramontanism. Within the Protestant domain there would be occasion to consider the early creative period of the Lutheran theology; the scholastic period in the 17th century; the Pietistic and Rationalistic movements in Germany; the implication of Lutheran theology with successive philosophies since the dawn of the 18th century; the controversies between Calvinism and Arminianism; the contrasts between High Church, Low Church and Broad Church parties in the Anglican Establishment; the wide-reaching tendencies born of the Wesleyan revival; the initiation in Germany of the great movement of biblical criticism and its extension to other countries; and the rise and influence of the Ritschlian theology.

Among theological writers eminent for their representative position, or breadth of influence, or both, we may specify, in the Greek Church, Origen, Athanasius, Basil, Gregory Nazianzen, Gregory of Nyssa, Cyril of Alexandria, Theodoret and John of Damascus; in the Latin or Roman Church Augustine, Anselm, Peter Lombard, Alexander Hales, Albertus Magnus, Thomas Aquinas, Bonaventura, Duns Scotus, Suarez, Bellarmin, Petavius and Perrone; in the Lutheran Church, Luther, Melanchthon, Chemnitz, Gerhard and Schleiermacher; in the Reformed Church on the Continent, Zwingli, Calvin, Bullinger, Turretin, and Arminius; in England and her dependencies, Hooker Chillingworth, Pearson, Bull, Baxter, Owen, Howe, Butler, Wesley and Edwards.

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Stearns, 'Present-Day Theology'; Strong, 'Systematic Theology'; Van Oosterzee, 'Christian Dogmatics.'

HENRY C. SHELDON,
Professor of Systematic Theology, Boston University.

THEOPHRASTUS, Greek philosopher: c. 372-287 B.C.; was a student of Plato and successor to Aristotle as head of the Peripatetic school of philosophy. He conducted the school with much success for 35 years, and was highly honored at home and abroad. He was greatly interested in natural history and won renown for his writings on botanical subjects. His 'History of Plants' and 'Theoretical Botany' are preserved as also are fragments of his works on 'Mineralogy,' 'Fire,' etc. His best known work is 'Characters,' a series of sketches which has repeatedly been translated. Consult Zeller, E., 'Aristotle and the Earlier Peripatetics' (Eng. trans., London 1897); Gomperz, T., 'Greek Thinkers' (Vol. IV, Eng. trans. by Berry, New York 1912) and others. An especially notable edition of 'Characters' is that of the Leipzig Philological Society (1897).

THEOREM. See GEOMETRY.

THEORETICAL MECHANICS. See MECHANICS.

THEORY OF ASSEMBLAGES. See ASSEMBLAGES, GENERAL THEORY OF.

THEORY OF CURVES. See CURVES OF DOUBLE CURVATURE.

THEORY OF EQUATIONS. See EQUATIONS, GENERAL THEORY OF.

THEORY OF FUNCTIONS VARIABLE. See COMPLEX VARIABLE, GENERAL THEORY OF FUNCTIONS OF.

THEORY OF GROUPS. See GROUPS, THEORY OF.

THEORY OF NUMBERS. See NUMBERS, THEORY OF.

THEORY OF PROBABILITY. See PROBABILITY, THEORY OF.

THEORY OF SURFACE. See SURFACE, THEORY OF.

THEOSOPHY, as its Greek derivatives signify, means Divine Wisdom — wisdom concerning God. It is that general system of thought which has appeared in all ages shaping itself in one form and another and which has attempted to explain the nature of God, the universe and man's relation thereto. Among the Orientals it is conspicuous in the philosophic systems of China, India and Egypt. It is seen in the works of the Gnostics, the Neo-Platonists and the Cabalists, and in the speculations of Böhme, Schelling, Eckhart and in the teaching of Kapila and Shankaracharya, Pythagoras and Plato, Valentinus and Plotinus, Simon Magus and Apollonius of Tyana, Paracelsus and Bruno. It represents a body of tradition which has been preserved from earliest times and is not only found in the philosophic and speculative writings of those above mentioned and many others, but has been taught from time to time by sundry religious and mystical orders, — in the Far East by the Gurus and Initiates, and in Greece by the various schools of the mysteries. During the Middle Ages traces of the teaching are to be found in Masonry and Mediæval Mysticism, and later in the Order of Rosicrucians, and it has at all times comprised the esoteric side of the great religions of the world.

The Theosophical Society.— In modern times this name is given to an amalgam of occult, Indian and modern spiritualism made by a Russian named Helena Petrovna Blavatsky (q.v.) who, on 17 Nov. 1875, aided by Col. Henry Steel Olcott of New York, founded in that city the Theosophical Society, and modern theosophical thought owes its origin and propaganda to the writings and efforts of herself and her colleagues in this society. The objects of the society as originally declared were to collect a library and diffuse information concerning secret laws of nature. Later these objects were remodeled, and as now framed are:

1. To form a nucleus of the universal brotherhood of humanity, without distinction of race, creed, sex, caste or color.
2. To encourage the study of comparative religion, philosophy and science; and
3. To investigate the unexplained laws of nature and the powers latent in man.

«Assent to or sympathy with the first of these objects required for membership, the remaining two being optional and intended to subserve the first. The society has no dogmas or creed, is entirely non-sectarian, and includes in its membership adherents of all faiths and of none, exacting only from each member the tolerance for the beliefs of others that he would wish them to exhibit toward his own. Their bond of union is not the profession of a common belief, but a common search and aspiration for truth. They hold that truth should be sought by study, by reflection, by purity of life, by devotion to high ideals, and they regard it as a prize to be striven for, not as a dogma to be imposed by authority. They consider that belief should be the result of individual study or intution, and not its antecedent, and should rest on knowledge, not on assertion. They extend tolerance to all, even to the intolerant, not as a privilege they bestow, but as a duty they perform, and they seek to remove ignorance, not to punish it. They see every religion as an expression of the Divine Wisdom, and prefer its study to its condemnation, and its practice to proselytism. Peace is their watchword as truth is their aim.» «There is no religion higher than Truth» is the motto of the society. The general headquarters of the society are at Adyar, Madras, India, the residence of Colonel Olcott, its president-founder.

Its Aims.— It is stated that in the foundation of the Theosophical Society and in the writing of her various works, Madame Blavatsky was directed and aided by certain Eastern adepts or sages, whose pupil she had been for many years, and that the purpose of the movement was to stem the tide of materialism and agnosticism, which then threatened to engulf the thought of the age, and to stimulate transcendental research. Doubtless the fullest and the most authoritative statement of the ends which the modern theosophical movement were intended to accomplish is to be found in the following letter written by one of those adepts to one of his Western pupils:

«You can do immense good by helping to give the Western nations a secure basis upon which to reconstruct their crumbling faith. And what they need is the evidence that Asiatic psychology alone supplies. Give this and you will confer happiness of mind on thousands. . . . This is the moment to guide the recurrent impulse which must soon come, and which will push the age toward extreme atheism, or drag it back to extreme sacerdotalism, if it is not lead to the primitive soul-satisfying philosophy of the Aryans. . . . You and your colleagues may help to furnish the materials for a needed universal religious philosophy; one impregnable to scientific assault, because itself the finality of absolute science; and a religion that is indeed worthy of the name since it includes the relations of man physical to man psychical, and of the two to all that is above and below them. . . . Its (the society's) chief aim is to extirpate current superstitions and skepticism, and from long-sealed ancient fountains to draw the proof that man may shape his own future destiny, and know for a certainty that he can live hereafter.» Since then a considerable literature has sprung up within the society which, it is believed, has to no slight extent influenced the thought of the closing decades of the 19th century and made possible the almost popular interest in the unseen world. Among the leaders of theosophical thought after the death of Madame Blavatsky were Mrs. Annie Besant, C. W. Leadbeater, A. P. Sinnett and G. R. S. Mead, — Mrs. Besant being Madame Blavatsky's successor in the esoteric as well as in the exoteric work of the society. Through the writings of these theosophists the so-called theosophical theories, which for centuries have seemed vague and speculative, besides being greatly amplified, have been presented in a form more definite than at any other time in the history of such thought, the teachings now no longer resting upon tradition and intuition, if indeed they ever did wholly so, but largely upon investigations made into the supra-physical realms of nature by highly developed men whose trained powers enable them to respond sympathetically to vibrations of a finer order than those which the normal man is able to sense, and to come thus into conscious relations with subtler regions of nature within and extending vastly beyond the physical world. The training whereby these powers are gained is begun in the esoteric department of the Theosophical Society and falls more especially under its third object, which deals with the unexplained laws of nature and the powers latent in man.

Fundamental Principles.—Among the facts asserted by some theosophical writers as being known to themselves and capable of verification by those who are willing to make the necessary sacrifices to gain the required powers are: (a) the existence of a few highly evolved men, called Adepts or Masters — not solely of any one nation, but of any of the advanced nations — who have gained these divine powers in their fullness; that they exist now as in the past; that they are substantially omniscient so far as the laws and conditions of our own solar system extend, and that their high stage of progress entitles them to advancement beyond human conditions, but that they of their own free will have chosen to remain in touch with humanity in physical incarnation, that they may aid in its evolution; that it is from the brotherhood of these great adepts that from time to time have come into the outer world the great world teachers and that in their keeping has been the Wisdom-tradition, which in every age they have caused to be expressed in suitable form; that there have always been pupils of these men, and that theosophical teaching is published to the world to-day at their instigation and through a few of their pupils; (b) the existence of a very subtle order of matter, far finer than the ether which transmits light, upon which is impressed photographically, so to speak, in the form of living pictures, every scene or happening, however great or small, which has ever occurred from the very beginning of things and throughout the extent of the universe; that to this subtle material has been given the name of the Akâshic Records, or the Memory of Nature; that not only does the trained observer who has acquired the power of sensing these conditions of the subtler medium of the universe, or of responding sympathetically to its vibrations, *see* vividly the particular occurrence to which he turns his attention, but he *hears* and *feels*, etc., just as did the actors in any particular event which may be under review, perceiving their thoughts and feelings as well as seeing and hearing the outward conditions of the scene; that thus he can accurately, in proportion to his powers of observation, perceive any occurrence of the past, no matter when it may have happened, and in this way can know the true events of history; that he may also direct his vision to any period in the life of a planet and trace out its various evolutionary processes, and that he may thus enter a limitless field of observation wherein he may learn at first hand of the obscurer laws of nature; (c) that by the exercise of their highly evolved powers the Adepts or Masters of Wisdom can make definite experimental research into the Akâshic Records in quite as real a sense as the physicist makes his investigations within the physical world, and that they are, with these and other powers possessed by them, enabled to ascertain and teach certain general principles as definite facts, all of which are now and have ever been known to them, and very many of said facts have to a more or less extent, been proven by the investigations of those of their pupils who have fitted themselves to do such work. In 'The Secret Doctrine' Madame Blavatsky mentions three such principles as being the fundamentals of theosophy; they are:

1. An Omnipresent, Eternal, Boundless and Immutable Principle, on which all speculation is impossible, since it transcends the power of human conception and can only be dwarfed by any human expression or similitude. It is beyond the range and reach of thought — unthinkable and unspeakable.

2. The Eternity of the Universe *in toto* as a boundless plane; periodically «the playground of numberless universes incessantly manifesting and disappearing» called «the manifesting stars,» and the «sparks of Eternity.»

3. The fundamental identity of all souls with the Universal Over-Soul, the latter being itself an aspect of the Unknown Root; and the obligatory pilgrimage for every soul — a spark of the former — through the cycle of incarnation, or necessity, in accordance with cyclic and Karmic law, during the whole term.

Cosmogenesis.—According to the theosophist all manifestation has its origin in the Absolute, of whom naught can be said save that "He is." As Mrs. Besant eloquently describes it in 'The Ancient Wisdom,' "Coming forth from the depth of the One Existence, from the One beyond all thought and all speech, a Logos, by imposing on himself a limit circumscribing voluntarily the range of His own Being, becomes the Manifested God, and tracing the limiting sphere of His activity, thus outlines the area of His Universe. Within that sphere the Universe is born, is evolved and dies; it lives, it moves, it has its being in Him; its matter is His emanation; its forces and energies are currents of His life; He is immanent in every atom; all-pervading; all-sustaining, all-evolving; He is its source and its end, its cause and its object, its centre and circumference; it is built on Him as its sure foundation, it breathes in Him as its encircling space; He is in everything and everything in Him. Thus have the sages of the Ancient Wisdom taught us of the beginning of the manifested worlds. From the same source we learn of the self-unfolding of the Logos into a threefold form; the First Logos, the Root of all Being; from Him the second, manifesting the two aspects of life and form, the primal duality, making the two poles of nature between which the web of the universe is to be woven—Life-Form, Spirit-Matter, Positive-Negative, Active-Receptive, Father-Mother of the worlds. Then the Third Logos, the Universal Mind, that in which all archetypically exists, the source of beings, the fount of fashioning energies, the treasure-house in which are stored up all the archetypal forms which are to be brought forth and elaborated in lower kinds of matter during the evolution of the universe. These are the fruits of past universes, brought over as seeds for the present." From the Third Logos comes forth the seven Great Logoi, sometimes called the Seven Spirits before the throne of God; and as the divine outbreathing pours itself ever further outward and downward, from each of these we have upon the next plane Seven Logoi also, together making up on that plane 49. Omitting the detail of intermediate hierarchies, it is said that to each of these 49 Logoi belong millions of solar systems, each energized and controlled by its own solar Logos. Thus the difference is vast between the Great Logoi, the Trinity standing next to the Absolute, and the Logos of a single solar system, though the latter is far greater and more sublime than mankind has ever yet conceived the Deity to be. It is said that what happens at the beginning of a solar system (such as our own) is, allowing for certain obvious differences in the surrounding conditions, identical with what happens at the reawakening after one of the great periods of cosmic rest. Before a solar system comes into existence we have on its future site, so to speak, nothing but the ordinary conditions of interstellar space, that is, the seven subdivisions of the lowest cosmic or universal plane. These, from the viewpoint within our system, are identical with the matter of the highest, or the atomic subplanes of each of our planes. Upon this matter is poured out the energy of the third aspect of the Logos of the system, called the Third Logos, resulting in the quickening of the vitality which pervades all matter, so that when electrified by it the atoms of the various planes develop all sorts of previously latent attractions and repulsions, and enter into combinations of all kinds, thus by degrees bringing into existence all the lower subplanes of each plane, that is, the six planes below the atomic subplane, until we have before us in full action the marvelous complexity of the seven planes of nature and their respective seven subdivisions as they exist to-day. These planes represent both the physical and the unseen parts of the system, the former being its most densified phase and each plane of the latter being made up of matter of a gradually ascending scale of fineness. These planes are called respectively, (1) the physical plane, (2) the astral plane, (3) the mental plane, (4) the buddhic plane, (5) the nirvanic plane, (6) the paranirvanic plane and (7) the mahaparanirvanic plane, each being a definite region of the system, and their various subdivisions appearing in a general way, the same as the subdivisions of the matter of the physical plane, namely, as solids, liquids, gases and four states of ether. The matter of the subtler planes, however, is permeable, one order freely interpenetrating another and all extending both within and without the physical. The properties of each plane are also said to have an additional dimension to the one next preceding it in density. Thus the physical plane having three, the astral has four, the mental five, and so on. As stated, the highest or seventh subdivision of each plane is the atomic matter of that plane, that is, is homogeneous and cannot be further subdivided without undergoing an entire change of properties. Thus in breaking up the ultimate physical atom, it assumes the properties of the matter of the complex lowest subplane of the astral plane; in breaking up the astral atom it becomes of the lowest grade of matter of the mental plane, and so on. After the matter of all the subplanes of the system is by the action of the Third Logos formed and vivified, there is poured out upon it the energy of the second aspect of the Logos of the system, called the Second Logos, and is sometimes known as the monadic essence. The effect of this outpouring is to build the forms of the seven kingdoms of nature—the three elemental or pre-mineral, the mineral, the vegetable, the animal and the human. On the downward arc of its mighty curve this monadic essence simply aggregates round itself the different kinds of matter of the various planes, so that all may be accustomed and adapted to act as its vehicles; but when it has reached the lowest point of its *involution* or immeshing in matter and turns to begin the grand upward sweep of *evolution* toward divinity, its object is to develop consciousness in each of these grades of matter in turn, beginning with the physical—the lowest. When in the highest animal life this monadic essence or evolving soul mass reaches the ultimate limit of evolution in that type of forms, it is met by a third outpouring of Logic energy, that of the first aspect of the Logos of the system, called the First Logos, resulting by this union in the formation of the numberless human Egos—the individualization of the One Self in man. It is the presence within man of this third outpouring of the Divine Life, this spark of the One Self, that guarantees to him immortality, which, from this point on, the Ego, or real man, wins through innumerable incarnations in physical bodies.

Anthropogenesis.—As the worlds are septenary in their constitution, so also is man. He has on the physical plane (1) *a physical body,* the dense or visible portion of which is composed of solids, liquids and gases, and the etheric portion thereof is formed of the four subdivisions of ether. Pervading these is (2) *vitality,* derived from the sun and specialized by the etheric part. On the astral plane he has (3) *an astral or desire body.* And on the lower four levels of the mental plane he has (4) *a mind body.* These four principles constitute the personality, or what is often called the lower quaternary. On the three upper levels of the mental plane he has (5) *a causal or higher mental body,* the storehouse of all his experiences, past, present and future; on the Buddhic plane, (6) *a buddhic or bliss body,* wherein the inherent unity of all life is directly perceived, not as an intellectual concept, but as a sublime experience, and on the nirvanic plane he has (7) *a nirvanic or Atmic body,* the body of absolute reality. These last three constitute the Reincarnating Ego, the individuality, the soul which lives and grows throughout the period of solar manifestation. The other two planes may be termed the planes of the Self, or pure spirit. The matter of the various planes of nature entering into the composition of man's sundry bodies is vivified with the involving life of the monadic essence, the law of whose progress is to sink deeper and deeper into matter, while the law of the evolution of the Self using these bodies as vehicles of his consciousness is upward and out of matter. This apparent opposition of forces in man gives rise to the usual ideas concerning his lower and higher natures, and explains the meaning of evil. One's desires, thoughts and emotions are not himself, but the changing phantasmagoria of the living essence of his lesser vehicles which it is his business to learn to control and purify, until they become perfect instruments for his use,—for the real man within is none other than the changeless, eternal Self.

When the human Egos began their long pilgrimage of incarnations they at first took bodies on planets other than the one on which we now live. There are in our solar system seven planetary schemes of evolution, each the realm of a planetary Logos, and they are called, in the order of their distance from the sun, (1) the Neptune scheme, (2) the Uranus scheme, (3) the Saturn scheme, (4) the Jupiter scheme, (5) the Earth scheme, (6) the Venus scheme and (7) the Vulcan scheme. Each scheme consists of a chain of seven planets and each proceeds on independent lines, there being no intermingling of their activities during their normal course. The first and fifth of this series have each three physical planets, the others one each. The two physical planets of the first scheme besides Neptune are as yet unseen by the telescope. The two of the fifth, in addition to our earth, are Mars and Mercury. The non-physical planets in the schemes are of the matter of the astral and mental planes. Each scheme of evolution is worked out by means of seven Manvantaras or periods of manifestation, each manvantara consisting of seven Rounds, each round consisting of seven World Periods (following each other on seven planets in succession) and each world period consisting of seven Root Race Periods, any one of the latter covering periods of millions of years. The present humanity on this planet has passed four times around the planets of its chain, and through a fraction over four root race periods. The last planet occupied by us during the present round was Mars and the next will be Mercury. The two root races next before the present fifth root race of this planet were the Atlantean and the Lemurian races. The fifth root race has thus for developed as far as its fifth subrace and it stated that the beginnings of a new subrace, the sixth, may be found to-day in America.

Reincarnation and Karma.— Omitting all mention of the interesting career of the reincarnating egos through the primigenous conditions of the first three rounds of our own planetary chain and even of the first four root races of this present fourth round, it will suffice to show that among the undeveloped subraces of the present fifth root race reincarnation takes place within a brief period after the death of the body; that after each death there is a stay of more or less duration on the astral plane followed quickly by another physical incarnation. Later on as the life experiences bring greater growth to the incarnating soul, when he has developed some of the finer emotions, his stay in the invisible world is prolonged by an additional period in a specially protected and blissful region of the mental plane called «devachan,» the heaven world. Here his stay is proportional to the degree of his nobler earth experiences, usually lasting, for the average man of substantial attainments who has lived to a good age, about 15 centuries. Upon the ending of this devachanic life there remains only the reincarnating ego, the lower bodies constituting the personality having disintegrated on their respective planes; but the principles or qualities animating them have meanwhile left their impress upon the ego. In sending forth his next personality the action of the ego is colored and limited by the stamp upon it of these characteristics developed by the previous personality, so that the new personality begins his life cycle at the highest stage of growth reached by the previous one. This process of reincarnation goes on in «the three worlds» for vast periods of time, not on one planet alone, but on many, as the human life-wave passes from one to another — from one whose life processes have begun to wane to another more fitted to be the field of higher human possibilities, until at length the end is attained for which all manifestation seems to have been caused — the perfect growth of the soul, the unfoldment of all his potential divinity. The ethical law which governs the conditions of our lives, physical and supra-physical, is called Karma, and it is ineradicably operative in Reincarnation. It may be defined as the law of action and result. By virtue of the operation of this law, effects which cannot be ascribed to any immediate cause may be traced to causes existing in other incarnations of the same ego, thus establishing one's ultimate, personal responsibility for whatever may befall him. Furthermore, owing to this law, one may and does at each moment of his present life produce by his own actions, feelings and thoughts definite effects in the subtler order of things, resulting in conditions for his next earth life wholly of his own making.

Thoughts build character.
Desires make opportunities.
Actions make environments.

So that whatever one may suffer or enjoy, attain to or fall from is brought about as the result of his own action, in obedience to this law of absolute justice. It is the alternate experience of pleasure and pain which man encounters during his stages of ignorance that develops within him wisdom; and the opportunities guaranteed to him for the accomplishment of this end through Reincarnation and Karma are well nigh limitless. These two doctrines are perhaps the most far-reaching of all the theosophic teaching, as they seem to clear up a host of perplexing questions and establish the basis for a satisfying philosophy.

Propaganda.—Among the results of theosophic propaganda is the restoration to the Western world of the said doctrines of Reincarnation and Karma, and the elimination of the many perversions of them existing in the East. Another is the occult proof produced of the definite objective reality and potency of thoughts and emotions, showing that these forces are as to their respective planes as visible and real as physical objects are on the physical plane, and that every thought is a living, active entity, persisting for a length of time proportional to the strength that is put into its creation and wields a greater or less influence on those with whom it may come into touch. (See Mr. Leadbeater's 'Man Visible and Invisible,' illustrated, and Mrs. Besant's 'Thought Forms,' illustrated). Still another is the order which it has brought out of the chaos of the apparently unrelated data of metaphysics, mysticism and the neo-psychology, including the facts of clairvoyance, clairaudience, mesmerism, hypnotism, telepathy, astrology, apparitions, psychometry and the like. And still another is the establishment by irresistible evidence of the basic unity of all the great world religions and their fundamental relation to an unprejudiced and open-minded science. To help the religions to clear away their non-essential accretions, to sink into insignificance doctrinal differences, to bring to the fore their points of unity, to study their doctrines and traditions in the spirit of brotherliness and to help each from his own particular standpoint is one of the chief ends to which the theosophist bends his efforts. He does not seek to found a religion, but to expound those we already have, and so give them a deeper meaning and a richer life. While the theosophist limits himself to no particular form of creed, yet the following three truths may be said approximately to include the broad scope of his belief:

1. God exists, and He is good. He is the great lifegiver who dwells within us and without us, is undying and eternally beneficent. He is not heard, nor seen, nor touched, yet is perceived by the man who desires perception.
2. Man is immortal and his future is one whose glory and splendor have no limit.
3. A Divine law of absolute justice rules the world, so that each man is in truth his own judge, the dispenser of glory or gloom to himself, the decreer of his life, his reward, his punishment.

Occultism.— Unless he finds the religion to which he happens to be connected insufficient to meet the demands of his higher nature, the theosophist is apt to seek through the esoteric side of his philosophy the gateway of Occultism, in order that he may prepare himself for a more serious religious life. Occultism, as distinguished from the Occult Arts, or Magic, is that system of endeavor which, teaching the methods whereby the personality, or lesser, or more human side of man may be made to expand and embrace his higher or divine nature, leads its votaries along a difficult and narrow pathway of rigid virtue and mental and emotional control, and so requires a firm moral foundation upon which to build the extraordinary powers pertaining to the unseen world. The true Occultist possesses unselfishness, justice and true knowledge; he has compassion and wisdom; his desire nature is purified and his habit of mental concentration fixed; «the contents of his consciousness are something more than his five-sense perceptions *plus* the deductions he draws from them by his reason, and such vague ideas and intuitions as he may possess.»

Through Occultism the aspirant, wearying of the phenomenal world, seeks to outstrip his fellows in evolution and within a few strenuous incarnations to accomplish what the mass of humanity in the normal course will only attain to in long reaches of time, namely, the highest adeptship or liberation from the «wheel of rebirth.» In doing so he treads a path which, according to occult teaching, has three great divisions:

1. The probationary period, before any definite pledges are taken or initiations (in the full sense of the word) are given. This carries a man to the level necessary to pass successfully through what in theosophical books is usually called the critical period of the fifth round.
2. The period of pledged discipleship, or the path proper, whose four stages are often spoken of in Oriental books as the four paths of holiness. At the end of this the pupil obtains adeptship — the level which humanity should reach at the close of the seventh round.
3. What may be called the official period, in which the adept takes a definite part (under the great Cosmic Law) in the government of the world, and holds special office connected therewith, but none of the details of this period can be made known.

The probationary path has five stages but the division between its stages are less decidedly marked than those of the higher groups, and perfection is not required in anything during this period, only a serious effort toward it. In the *first* stage the candidate for adeptship acquires a firm intellectual conviction of the impermanence of mere earthly aims; in the *second* a perfect indifference to the fruits of his own action; in the *third* (a) perfect control of mind, (b) of conduct, (c) a generous tolerance, (d) endurance, (e) one-pointedness, (f) confidence in his Master and himself; in the *fourth* an intense desire for union with the highest; and in the *fifth* he gathers up and strengthens his previous acquisitions for the next great step, which will set his feet upon the path proper as an accepted pupil. During his life on the probationary path the pupil will have received much teaching from his Master, usually imparted during the sleep of his physical body, while he himself is clad in his astral body in full consciousness on the astral plane. He will also have been taught while thus functioning in the astral world to bring help, instruction and comfort to the inhabitants of that world, who having laid aside their physical bodies at the gateway of death have passed beyond the physical plane. This phase of occult work is sometimes called that of the *Invisible Helpers* and is performed, be it understood, by men still having physical bodies and who have developed this power of functioning consciously outside the same on inner planes. The pupil will further have been trained in mediation, and this effective practice both in waking consciousness and outside the physical body during its sleep will have quickened and brought into active exercise many of the higher powers.

When the pupil has developed the fifth qualification of the probationary path he is ready for initiation upon the part proper, henceforth to serve his Master, whom he now meets face to face, in helping forward the evolution of the race, his life, «to be offered up on the altar of humanity, a glad sacrifice of all he is, to be used for the common good.» This path consists of four distinct stages and the entrance to each is guarded by an initiation. Ere the second initiation can be passed the pupil must lose the sense that the separated, personal self is a reality, and must feel himself one with all; he must destroy doubt and superstition by knowledge; ere he passes the third he must bring into full working order the inner faculties, those belonging to the subtler bodies; now he needs to incarnate but once again; ere the fourth is passed he rids himself of desire and aversion and sees the One Self in all. At this stage he needs to return no more. The fourth initiation admits him to the last stage of the path where he throws off all clinging to life in form and all longing for even formless life. Then he casts off the «I-making» faculty — pride, irritability and ignorance, and henceforth dwells on the plane of unity. The man is then perfect, is free, the liberated one. He has won Nirvana. «He has completed man's ascent, he touches the limit of humanity; above him there stretches hosts of Mighty Beings, but they are superhuman; the crucifixion in flesh is over, the hour of liberation has struck and the triumphant 'It is Finished' rings from the conqueror's lips, . . . he has vanished into light nirvanic. But being now Master of Compassion as well as Master of Wisdom, he returns from that light to earth, henceforth to devote himself to the service of humanity with mightier forces at his command than he wielded while he trod the path of discipleship, bending all his sublime powers to the quickening of the evolution of the world. Such an one was the Buddha — such the Christ and such the few Great Souls who tread the earth to-day, secluded from its external strife, yet pouring down upon mankind from the great heights of their sublime advancement inestimable blessings, guiding by means of their divine powers whole races and nations, but unknown to all but the few earnest souls who come to them through the ancient gateway of Occultism, the portal of which has throughout all time stood ajar for the resolute pilgrim.»

Before the cycle of time shall close and all manifestation cease, the greater portion of mankind will have reached this high stage of growth. And then shall all be gathered unto Him for the great Cosmic rest only after æons and æons of time, to emerge again with Him, to be the Architects and Builders of future universes. Such are a few of the teachings of the Ancient Wisdom, given forth at this time as Theosophy and Occultism.

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The materials for the above sketch have been drawn more or less literally from the above-mentioned works.

A. P. Warrington,
Fellow of the Theosophical Society.

THEOTOKOS, a title given to the Virgin Mary by a decree of the Third Ecumenical Council, which met at Ephesus 431 to condemn the Nestorian heresy. The term means «bringing forth God» and is intended to formulate the fact implied in the annunciation of the angel to Mary "that holy thing which shall be born of thee shall be called the son of God." Theotokos (Latin, *Deipara*) implies that the child of Mary was of divine nature from the moment of his conception; that he was not born mere man, to whom, as Nestorius taught, the divine nature was subsequently imparted.

THERA, thā'rạ or thē'rạ, an island in the Ægean Sea, belonging to the Grecian Archipelago, the most southerly of the Cyclades. It is of volcanic formation and presents many interesting phases. New islands are formed from time to time, by its volcanic action, notably the last in 1866. Scientists have given the island considerable attention and many observations have been made and records kept. The soil is very fertile.

THERAMENES, thĕ-răm'ĕ-nēz, Athenian politician of the 5th century B.C. He first became prominent in 411 as a member of the Council of 400, but perceiving the inevitable downfall of that government he joined the opposing party and assisted in its overthrow. In 410 B.C. he was in command of a portion of the Athenian fleet, with which he cruised about and exacted tribute from the neighboring islands, and later he joined the fleet under Thrasybulus, with whom he took part in the battle of Cyzicus. He subsequently served with Alcibiades, participated in the siege of Chalcedon in 408 B.C. and in the capture of Byzantium. After the battle of Arginusæ, in 406, he repaired to Athens, and in order to exculpate himself for not saving the crews of the ships accused his colleagues of neglect, and through his testimony they were sentenced to death. In 404 B.C., when Athens was besieged by the Spartan general Lysander, Theramenes was sent as an envoy to negotiate terms with Sparta. He purposely remained on his mission for three months, during which time Athens was reduced to dire extremity and was forced to make peace upon such terms as to place her at the mercy of the Lacedæmonians. He was elected one of the Thirty Tyrants (q.v.) after the peace, and at first heartily supported the measures of the government. The violent measures of Critias and his colleagues, however, induced him to form an opposing party, which rapidly increased in strength. He was accused by Critias of being a public enemy, dragged to prison and forced to drink the hemlock.

THERAPEUTICS, that branch of medicine which deals with the treatment of disease. Natures cures; physicians treat. This is an old dogma as true to-day as it was when uttered over 2,000 years ago by a famous Greek physician. Scientists have termed that power of the human body the *vis medicatrix naturæ,* by means of which nature tends to right her own disordered organs, and it is important to recognize this all-important function of the body, and not to interfere by overzealousness in the use of potent agents with nature's own slowly acquired powers of self-restoration. An innocuous and half-hearted therapy, however, is not the logical system, even if such reconstructive powers of nature are granted. The modern conception of disease does not admit of ready characterization. In the articles on disease and pathology (q.v.) it is attempted to define what is meant by disease, but such definitions are far from being satisfactory because of the immense variety of diseased conditions, their manifold causation and their devious progressions. In all disease certain groups of physiological functions are altered, and in the attempt to aid nature to bring these disturbed physiological activities to a normal condition the chief work of the therapeutist lies. It makes little or no difference what the agencies may be that are used — often, as has been said, none are necessary — yet the ideal of the therapeutic art is to restore to normal condition, as far and as quickly as possible, the disturbed bodily functions. While it is true that the physician of to-day employs many of the agents used by physicians thousands of years ago, there is a far greater precision and a much more comprehensive series of ideas concerned in their use by the well-equipped modern therapeutist than was possible to his early predecessors. The one aim of the physician throughout the centuries has been the alleviation of suffering and the restoration of the diseased to health or to comfort; and notwithstanding the many small cliques and divergences of opinion, the progress toward scientific therapeutics has been steady and increasingly satisfactory. At the outset of this summary of therapeutics it may be well to consider for a moment the different classes of agents at hand by the use of which, singly or combined, the physiological functions of the body may be modified, and thus be made useful in the healing art.

Expressed categorically, the different therapeutic agents or systems are: (1) Suggestion-therapy; (2) Dietotherapy; (3) Physicotherapy; (4) Mechanotherapy; (5) Pharmacotherapy; (6) Surgicotherapy. Each of these will be briefly discussed.

Unquestionably the oldest and yet strongest therapeutic agent is suggestion. The power to heal by faith is not the special property of any sect or class, nor the exclusive right of any system. Belief in gods and goddesses, prayer to idols of wood, of stone, of gossamer fiction, faith in the doctor, belief in ourselves engendered from within or from without — these are all expressions of the great therapeutic value for healing that resides in the influence of mental states on bodily functions. These will not move mountains; they cannot cure consumption; they do not influence a broken leg, nor an organic paralysis; but suggestion, in its various forms, may be and is one of the strongest aids to all therapeutic measures. Of its abuse by designing hypnotists, blackmailers, clairvoyants and a motley crew of parasites, space does not permit particularization. The human mind is credulous — it believes what it wants or wills to believe; and the use of suggestion in therapeutics is one of great power for good and for evil.

The treatment of disease by diet constitutes another large branch of the therapeutic art. Modern chemistry has resolved all foods and drinks into their elements, and has given the physician valuable aids in the treatment of a large number of diseases. Many obscure disorders, such as diabetes, gout, myxœdema, obesity, etc., are closely allied with certain defects in the metabolism of certain physiological systems of the body. Many of these are best treated by a dietary regimen, combined, it may be, with other means. Many of the minor disorders of the digestive tract (see DIGESTION) are best treated by regulation of the diet.

By physicotherapy is meant the use of certain physical agents such as heat, cold, light, electricity, etc. Certain forms of application of the agents are termed (a) hydrotherapy (q.v.), in which heat and cold are applied by means of water; (b) phototherapy (q.v.), in which light is used in the treatment of disease. Sunlight, electric light, ultra-violet rays (Finsen's light), X-rays, radio-active substances — these all exert on the tissues of the body certain influences that, properly applied, may bring about restoration of disordered functions, and thus aid nature in curing disease.

Mechanotherapy is the use of mechanical movements in treatment. Massage, vibration, gymnastics, Swedish movements, etc., are some of the different forms in use. Under the name of osteopathy (q.v.) it is attempted to elevate one of the oldest aids to treatment, in use by the Greeks, Chinese, etc., to the rank of an exclusive system.

Under the terms pharmacotherapy and surgicotherapy are included the treatment of disease by drugs, so-called, and by surgical means. So far as treatment by means of drugs is concerned, it is interesting to note that practically all drugs act on the tissues of the body in some chemical or physicochemical manner. They may have a certain selective action on certain tissues of the body. Thus the large group of the alcohols, comprising ethers, aldehydes, chloroform, hypnotics — such as trional, sulphonal, veronal, urethane and a large number of others — have a selective action on the nervous tissues of the brain, benumbing their activities and causing drunkenness or anæsthesia or sleep, according to the dose or other conditions. Others act on sensory nerves, diminishing pain; such are cocaine, opium, antipyrin, acetanilid, phenacetin, cannabis, etc. Again, other remedies are chiefly on the intestines, giving the large group of cathartics, and so the entire list of drugs might be analyzed. Given a knowledge of the selective or generalized action of the drugs, the power that they may exert in correcting abnormal physiological activities is solely a matter of application and in accordance with the correct interpretation of the cause of the disturbed functions will the therapeutic application be of direct value or not. In other words, drugs are nothing more than chemical agents which may be used to modify certain physiological activities; if by their well-known power in modifying these activities other morbid activities may be corrected, they are agents for good. For a consideration of surgicotherapy, see SURGERY, HISTORY OF GENERAL.

One other phase of therapeutics remains to be considered. It has been pointed out that nature has resources of her own for overcoming certain types of disease. Can these natural powers be so played upon or affected as to increase their operation? Along this line new paths have been opened up since the recognition of a large class of diseases known as infectious. Bacteriology (q.v.) has taught that disease organisms (bacteria) cause the disturbance (disease) in the body not so much by their physical presence as by the extremely virulent poisons that they form. It is the struggle of the human body to get rid both of bacteria and poisons that makes the disturbance which is called the disease. Thus the diarrhœa of typhoid is one of nature's efforts to throw off poisons; the high temperature and crisis of pneumonia is a supreme effort of the body, which sometimes succumbs under it, to deal a death-blow to the pneumococcus, the micro-organism that causes the disease. The high temperature in malaria (q.v.) unquestionably kills off a great many of the parasites in the blood.

But in addition to these larger and more palpable efforts on the part of nature to overcome the invader, a series of subtle and intricate defenses are at work in the blood-serum, some of the elements of which are known. Thus in some diseases there is elaborated in the blood-serum a direct chemical antidote, an anti-toxin, to the poisons of the invading bacteria. Such a protective power is found in diphtheria (q.v.). (See ANTITOXIN). Vaccination, the discovery of which was almost the result of an accident, is a form of serum-treatment. (See SERUM-THERAPY). The details of the reasons why immunity is conferred by the modified smallpox of the cow are not yet known, as the true cause of smallpox is not indubitably proven, but the time is not far off when the different factors herein involved will be unearthed. A large number of other questions are concerned in this great question of natural and acquired immunity (q.v.).

Human progress has been likened to the advance of a drunken man, and it is certain that the ups and downs and side-lurches and backward steps in the path of therapeutics have been many; but withal there has been a broad blaze of progress. That which has been tried and been found to be true has been grasped and has become the heritage of the whole community. The physician class have shared with the people at large in the general movements; there have been many side-tracks from the broad road of therapeutics; innumerable *pathies* have had their little day or their 100 years; each in its turn has contributed what kernel of truth it possessed to the progress of the mass.

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SMITH ELY JELLIFFE, M.D.,
Editor of ‹Journal of Nervous and Mental Diseases.›

THERAPIA, a health resort on the Bosporus, nine miles north-northeast of Constantinople, of which city it is a suburb. It is the ancient *Pharmacia* («drug-cure») where tradition says Medea spread her drugs. One of the earlier patriarchs of Constantinople changed the name to Therapia («cure»). It marks the limit between what is locally called the Upper Bosporus and the Lower Bosporus. Here are the summer residences of European ambassadors, Turkish officials and wealthy Levantines.

THERESA, Saint. See TERESA, SAINT.

THERESIOPEL, tĕr-ā'zē-ō-pĕl, or **MARIA-THERESIOPEL,** mä rē'ä-tĕr-ā'zē-ō-pĕl (Hung. *Szabadka*), Hungary, a royal free town in the county of Bács-Bodrog, 25 miles southwest of Szegedin, in a broad plain between the Danube and the Theiss. The buildings worthy of notice are the churches of Saint Theresa, church of the Franciscans, a beautiful Greek church, town-house, etc., theatre, barracks, gymnasium and music-school. The industrial works include tanneries, linen and leather manufactories and dyeworks. Wheat, tobacco, wine and fruits are grown and cattle-raising is important. There is a brisk trade in horses, cattle, sheep, hogs, hides and wool. There is a fashionable watering-place in the vicinity. Pop. 94,610.

THERIAC, or THERIACA, a compound said to have been first prepared by Andromachus of Crete, who was physician to the Emperor Nero. It was supposed to be an antidote to poison, and continued in use throughout the Middle Ages. As prepared in Venice and other places it was a compound of 64 drugs, pulverized and reduced by means of honey to an electuary.

THERIODONTIA, a sub-order of the *Theromorpha* (q.v.), large extinct carnivorous reptiles, with shortened coracoid and double-headed ribs.

THERMÆ, thėr'mē (from the Greek *thermai*, signifying originally warm or hot springs), properly warm baths, but also applied generally to the baths of the ancients. During the Roman Empire the buildings for this purpose were constructed with great splendor and adorned with paintings, statuary, libraries, gymnasia and public walks. The baths of Nero, Titus, Caracalla and Diocletian at Rome were distinguished for the magnificence and luxury displayed in their construction. See BATH HOUSES.

THERMAL SPRINGS. See SPRING.

THERMIC FEVER. See SUNSTROKE.

THERMIDOR, thėr-mĭ-dôr' (Fr. tĕr-mē-dôr), the 11th month of the year in the calendar of the first French republic. It commenced on 19 July and ended on 17 August. See CALENDAR.

THERMIT, a name given by Goldschmitt to a mixture of fine aluminum filings or powder and iron oxide. When this mixture is ignited by some suitable means the aluminum unites vigorously with the oxygen of the iron oxide, forming a very pure variety of steel and a slag consisting mostly of aluminum oxide. This union of finely divided aluminum with oxygen gives a very intense heat, about 3,000° C. Besides the ordinary thermit (iron oxide and aluminum filings) other mixtures may be prepared from aluminum and the oxides of nickel, cobalt, chromium, manganese, etc. When these are ignited in a properly prepared crucible violent reaction takes place, the oxygen of the oxide being taken up by the aluminum, leaving a very pure metal, nickel, cobalt, etc. This process is now much used to get metals from those oxides that heretofore have resisted all ordinary methods of reduction. When ordinary thermit is ignited the temperature produced is so high that the iron and the slag are left in a molten and highly-heated condition. If this iron is allowed to flow on to another piece of iron or steel it will heat it enought to soften it and the whole will harden to a homogeneous mass. In this way it can be used to replace broken parts of machinery, to mend broken or cracked propeller shafts, to weld together railroad rails so as to form one continuous rail, etc. Some of the important features in this process are its cheapness, ease of execution and the fact that machinery, etc., can be repaired in position. The method is to surround the part to be repaired with an ordinary mold box; a magnesia-lined crucible with a plug in the bottom is placed over the opening; the thermit is placed in the crucible, ignited and as soon as the violent reaction has subsided the plug is pulled and the white hot metal allowed to flow into the mold. Iron tubes can be welded together by placing the ends in a mold and allowing the thermit product to flow in in such a way that the liquid slag first comes in contact with the tubes. The slag forms a protective covering which prevents the hot iron from uniting with them, though it does allow the tube ends to become hot enough to unite as one piece. Railway rails can be joined where they lie on the track, and large pieces of broken machinery in mines or on shipboard can be readily repaired without removal.

THERMO BAROMETER. See THERMOMETER.

THERMO-CHEMISTRY, or THERMAL CHEMISTRY, that branch of physical chemistry which deals with the thermal changes which occur when chemical reactions take place or when a body or system (such as a solution) undergoes certain kinds of physical change. Its precise limits are not easy to define, since the subject merges into ordinary chemistry on the one hand and into thermodynamics on the other. Any chemical operation can be considered from two points of view, according as we are interested in the modification that it produces in the nature of the substances that are involved or in the quantity of energy which is absorbed, liberated or otherwise transformed at the same time. It is the province of thermo-chemistry to investigate the transformations of energy that occur in such cases. The complete discussion of the energy-transformations that accompany a given chemical change should include the consideration of every type or form of energy which may be present; but the investigations which have hitherto been made have related chiefly to the quantities of heat which are liberated or absorbed, and it is to this circumstance that the science owes its present name, «thermo-chemistry.»

The quantity of heat that is liberated or absorbed during a proposed chemical reaction can be determined by causing the given reaction to take place in the interior of a calorimeter. The particular form of calorimeter that is to be used will naturally depend to a considerable extent upon the nature of the reaction that is to be studied. If the problem consists in the determination of the quantity of heat that is liberated when two given liquids are mixed, the calorimeter commonly consists of a platinum vessel, capable of containing from 500 to 1,000 cubic centimeters, placed inside of another vessel of silver; the space between the two vessels being filled with water. The liquids that are to be examined are brought to the same temperature as nearly as possible, and are then mixed in the platinum vessel. The rise of temperature of the calorimeter being noted, and the masses and specific heats of the various parts of the calorimeter (and its contents) being determined by separate experiments, we are then in position to calculate the quantity of heat energy liberated by the reaction. For detailed information with regard to the various kinds of calorimeters that are used, and for a discussion of the sources of error to which such instruments are liable, reference must be made to extended works upon heat and thermo-chemistry. (See the references at the end of this article).

In thermo-chemical work, the unit of mass is almost invariably the gram; and the gram is always understood, when no other unit is specifically mentioned. The unit of heat is also understood to be the calorie, which, for thermo-chemical purposes, is defined as the quantity of heat required to raise the temperature of one gram of water by one Centigrade degree, when the temperature of the water is in the vicinity of 18° or 20° C. The notation that is employed in expressing the results of a thermo-chemical experiment upon the heat that is developed by a given chemical reaction is simple. The formulæ of the substances that react are written within square brackets, and separated by a comma or a colon; it being understood that the number of grams that are present of any one substance is equal to the molecular weight of that substance. A sign of equality is written after the bracketed formulæ, and on the right hand side of this sign the number of calories of heat generated or absorbed by the reaction is written; a positive sign being prefixed (or suffixed) when heat is evolved, and a negative sign when it is absorbed. The indices that are attached to the symbols of the various elements are written above those symbols, instead of below. For example,

$$[H^2,O] = +68,360$$

signifies that when two grams of hydrogen and 16 grams of oxygen, both at about 18° C. and under ordinary atmospheric pressure, combine to produce 18 grams of water (also at 18° C.), the quantity of heat that is evolved is sufficient to raise the temperature of 68,360 grams of water by one Centigrade degree; the temperature of the water being about 18° C. When a compound is broken up into its constitutent parts, the bracketed formulæ are preceded by a negative sign. Thus the expression,

$$-[H,Cl] = -22,000$$

signifies that when, by any means, 36.5 grams of hydrochloric acid are decomposed so as to set free 1 gram of hydrogen and 35.5 grams of chlorine, the change is accompanied by the absorption of a quantity of heat that would be sufficient to raise the temperature of 22,000 grams of water by 1° C.

The "heat of formation" of a substance is the quantity of heat given out when the substance is formed from its constituents; it being taken as negative when the formation of the substance is accompanied by the absorption of heat. In general, any given substance may be prepared in various ways, from different materials or constituents; and in such cases the heat of formation will be different, according to the particular substances that are regarded as constituents. For example, sulphuric acid might be prepared from sulphur, oxygen and water, according to the equation

$$S + 3O + H_2O = H_2SO_4,$$

or from sulphur dioxide, oxygen and water, according to the formula

$$SO_2 + O + H_2O = H_2SO_4,$$

or from sulphur trioxide and water, according to the equation

$$SO_3 + H_2O = H_2SO_4;$$

and the heat of formation will be different in these several cases, if we regard the immediate materials from which the acid is prepared as the "constituents" of the acid. But if the acid is prepared from the elements sulphur, hydrogen and oxygen (all three being taken in certain standard initial physical states in each instance), then the heat of formation will be the same, whether these elements combine directly to form the acid, or whether the oxides of sulphur and hydrogen are first produced, and these subsequently combine to form the acid. In fact, the principle of the conservation of energy shows that when a body or a system of bodies passes through a succession of changes, either physical or chemical in nature, so as to pass from one given initial state to another given final state, the total change in the internal energy of the body or system is identically the same, whatever the nature of the transformations may be, by which the change is effected. Hence it follows that whenever the heat that is emitted or absorbed in the course of a reaction represents nothing but the decrease or increase in the internal energy of the system, the total quantity of heat that is emitted or absorbed will be entirely independent of the way in which the transformation takes place. If, however, the system performs external mechanical work in passing from its initial state to its final state, the heat energy that is actually given off will be less than that corresponding to the change in the internal energy by the amount which is expended in performing the external work. In many of the reactions that are considered in thermo-chemistry, the external work that is performed is too small to be of any material significance, and in these cases the heat energy that is emitted or absorbed in the passage from one state to another may be logically regarded as independent of the kind of transformation that the transition involves. In some cases, however, and particularly when the systems under consideration are partly or wholly gaseous, the external work that is performed is great enough to require serious consideration, and to obtain accurate results this work must be estimated and allowed.

The application of the principle of the conservation of energy to the determination of the heat of formation of a substance, when that heat cannot be directly observed, may be illustrated by the case of phosphorus. We have, when ordinary phosphorus is burned to the pentoxide,

$$[P^2, O^5] = +369{,}100;$$

which signifies that when 62 grams of ordinary phosphorus (the atomic weight of that element being 31) are burned to pentoxide, 369,100 calories of heat are emitted. A similar experiment with amorphous phosphorus gives the corresponding relation

$$[P^2, O^5] = +326{,}800.$$

Evidently the internal energy of the amorphous variety is less than that of the ordinary variety, since when both are converted into the same thing the amorphous phosphorus gives out sensibly less heat. The difference of the foregoing numbers is 42,300; and dividing this by 2 (since the foregoing numbers apply to 62 grams of the phosphorus), we reach the final conclusion that when 31 grams of ordinary phosphorus are converted into the same mass of amorphous phosphorus, the conversion is attended by the emission of 21,150 calories of heat. Similar experiments have been performed in great number upon compounds that are isomeric with one another; and yet the data that are available do not warrant any but the broadest generalizations. It appears, for example, that the internal energy of a compound that admits of isomeric modifications depends (1) upon the symmetry of structure of the molecule, (2) upon the natures of the atoms which are directly joined in the molecule, and (3) upon whether or not each molecule in the compound exhibits its maximum valency toward the molecules of other kinds with which it may be associated. Thomsen endeavored to discover, by thermo-chemical methods, whether a single bond between two adjacent carbon atoms is stronger or weaker than a double or triple bond. His methods and conclusions are perhaps not always beyond criticism, but he was led to believe, from his experiments, that a triple bond between two adjacent carbon atoms constitutes a much weaker connection than either the single or the double bond. This particular conclusion, it may be said, is in harmony with evidence on this point that has been collected in many other ways.

The methods of thermo-chemistry have been applied extensively to the investigation of problems in the theory of solutions, to the study of the affinity between acids and bases, and to the elucidation of many of the difficult points of physical chemistry. These applications, however, assume a knowledge not only of experimental and theoretical physics and chemistry, but also, and more particularly, a sound understanding of thermodynamics. Consult Muir and Wilson, 'Elements of Thermal Chemistry'; Thomsen, 'Thermochemische Untersuchungen'; Naumann, 'Thermochemie'; Planck, 'Grundriss der Allgemeinen Thermochemie.'

ALLAN D. RISTEEN,
Director Technical Research, The Travelers Insurance Company, Hartford, Conn.

THERMO-DYNAMIC ENGINE, a name applied to any form of steam engine or gas engine.

THERMODYNAMICS, or **THE MECHANICAL THEORY OF HEAT,** that branch of physical science which treats of the relation of heat energy to energy of other kinds, and particularly of the convertibility of heat energy into mechanical energy, and the converse. In order to discuss, quantitatively, the conversion of one kind of energy into another kind, we must first have a definite method of measuring each of them. Mechanical energy (see ENERGETICS) is measured by determining the amount of work that a given quantity of it can perform; the customary unit employed for this purpose being the «foot pound» or the «metre-kilogram» in engineering practice and the «erg» in scientific work; the «erg» being defined as the quantity of work done in overcoming a resistance of one dyne, through a distance of one centimeter. The unit employed in the measurement of heat is almost universally the quantity of heat required to raise the temperature of some definite mass of water through one degree, on some stated part of the thermometric scale. The ordinary «British thermal unit,» which is used in engineering practice in English-speaking countries, is the quantity of heat required to raise the temperature of one pound of water by one Fahrenheit degree; and in countries that use the metric system, the engineering unit is the quantity of heat required to raise the temperature of one kilogram of water through one centigrade degree. As the specific heat (q.v.) of water varies slightly at different temperatures, these definitions are not absolutely definite, unless the part of the thermometric scale at which the experiment is to be performed is specified. Unfortunately there is no general agreement among engineers on this point; and for most purposes in practical engineering it is customary to ignore the slight variation in the specific heat of water and to consider the foregoing definitions to be sufficiently precise as they stand. For scientific purposes, where the greatest possible accuracy is required, this course is not permissible, and it becomes necessary to specify the particular degree through which the temperature of the water is to be raised. Even here there is no definitely established convention; but there appears to be a growing tendency to adopt the degree that extends from 14.5° C. to 15.5° C. In scientific work, too, it is customary to define the thermal unit in terms of a gram of water, instead of a kilogram; and the scientific heat unit (which is called the «small calorie,» to distinguish it from the «greater calorie» that is used in engineering) may be defined as the quantity of heat required to raise the temperature of one gram of water from 14.5° C. to 15.5° C. The quantity of heat required to raise the temperature of one gram of water from 3.5° C. to 4.5° C.—4.0° being the temperature at which water has its maximum density — is also known as the «therm.»

The science of thermodynamics is founded upon two general, fundamental laws, which, so far as we are aware, are absolutely rigorous and which are respectively known as the «first» and «second» laws. These we shall consider in order.

The «first law of thermodynamics» is nothing but a special application of the general principle of the conservation of energy. (See ENERGETICS). It states that whenever heat energy is converted into mechanical energy (or the reverse), then for each unit of one kind of energy that disappears there is always a perfectly definite and constant quantity of energy of the other kind which appears. Mayer and Joule discovered this fact independently, about the year 1840. There has been in the past some considerable controversy as to the credit that should be assigned to these respective investigators. We cannot enter into this discussion, but the reader who desires to follow it up will find an admirable and very fair statement of the facts of the case in two papers on the Copley medalists of 1870 and 1871, in Tyndall's 'Fragments of Science.' Joule did a vast amount of experimental work for the purpose of determining the exact value of the «mechanical equivalent of heat,» as the constant is called, which expresses the number of units of mechanical energy that are equivalent to one unit of heat; and in the course of his labors he tried many different experimental methods. (Consult 'The Scientific Papers of James Prescott Joule'). His best known method consisted in stirring a known mass of water and measuring the rise in temperature so produced as well as the quantity of mechanical work expended in the stirring. He concluded that the temperature of one pound of water is raised by one Fahrenheit degree by the expenditure of 772 foot-pounds of mechanical energy. This constant, which is known as «Joule's equivalent» and is denoted by the symbol J, has played an all-important part in engineering and scientific work for more than half a century. A better value of it was obtained by Rowland in 1879 (consult 'The Physical Papers of Henry Augustus Rowland'); but the prestige of Joule was so great that the superiority of Rowland's work was not generally recognized for many years. Rowland's method was similar to that of Joule, but he worked with far better apparatus, and took advantage of the advances that had been made since Joule's work was done, both in calorimetry and in thermometry. It was in the course of this work that Rowland made the discovery that when temperature is defined in accordance with the scale of the normal, constant-volume air thermometer, the specific heat of water has a minimum value at a little above 30° C.,— a discovery which implies a high degree of precision in the experimental methods employed, and which has been abundantly verified by later investigators. Rowland's value of the mechanical equivalent of heat may be stated as follows: Taking as the unit of heat the quantity of heat required to raise the temperature of one kilogram of water from 14.5° C. to 15.5° C., the mechanical equivalent is 427.4 kilogram-metres at sea-level in the latitude of Baltimore. If the unit of heat is the quantity of heat required to raise the temperature of a pound of water from 59° F. to 60° F., then the mechanical equivalent is 779.0 foot-pounds. If the unit of heat is the quantity of heat required to raise the temperature of one gram of water from 14.5° C. to 15.5° C., then the mechanical equivalent is 41,890,000 ergs. Numerous other experimenters have made determinations of the mechanical equivalent, both by the method followed by Joule and Rowland, and by other methods. Prominent among these is Griffiths, who heated the water in his calorimeter mainly by means of a known electrical current, traversing a known resistance, and hence giving out a known quantity of heat. Taking as a unit of heat the quantity of heat required to raise the temperature of a kilogram of water from 14.5° C. to 15.5° C., Griffiths found the mechanical equivalent to be 427.45 kilogram-metres at sea-level in the latitude of Greenwich. Rowland's value, when expressed in these same units and corrected to the latitude of Greenwich, is 427.0. For further details concerning the experimental determination of the mechanical equivalent, consult Preston, 'Theory of Heat'; and for numerous interesting illustrations of the first law of thermodynamics, consult Tyndall, 'Heat a Mode of Motion.'

The «second law of thermodynamics» is hard to explain in a limited space, or without the use of higher mathematics; and, as Rankine remarked, its exposition has been much neglected by the writers of popular works, so that «the consequence is that most of those who depend altogether on such works for their scientific information remain in ignorance, not only of the second law, but of the fact that there is a second law; and knowing the first law only, imagine that they know the whole principles of thermodynamics.» In its simplest form, the «second law» merely states that heat always tends to pass from a hotter body to a colder one. This fact is obvious enough in its simpler manifestations; for every housewife knows that to make the kettle boil she must put it on the stove and not in the refrigerator. It is not so evident, however, that there are no conditions whatever under which heat will pass of its own natural tendency from a lower temperature to a higher one. It is not evident at first thought, for example, that we cannot make a burning glass big enough to give a temperature, at its focus, which shall be higher than the temperature of the sun; yet we cannot do so, if the second law of thermodynamics is true, for the heat at the focus of the glass certainly comes from the sun, and if that focus were hotter than the sun, we should have a case in which heat is passing by its own natural radiative tendency from a cooler body (the sun) to a hotter one (the focus of the glass). The second law was first proposed, as a broad principle of nature, by Clausius; and although numerous distinguished mathematicians and physicists have questioned its validity from time to time, it is now recognized as a great, universal truth, applicable to all classes of phenomena, without exception, so long as we are dealing with large masses of matter. We cannot undertake, here, to discuss the seeming exceptions that occur in connection with particles microscopic or less in size. (See BROWNIAN MOVEMENT). It is indeed true that heat can be abstracted from a body and made to pass into a warmer one, and this is actually done on a commercial scale in cold storage plants and in the manufacture of artificial ice; but the point is that this feat cannot be accomplished without the expenditure of energy. We are to think of heat, in its tendency to pass from a higher temperature to a lower one, in much the same way as we think of water tending to run down hill. Water will not run up hill of its own accord, but it may be forced to pass from a lower level to a higher one by the expenditure of energy upon a pump or other equivalent device. The correctness of Clausius' hypothesis with regard to heat is substantiated by the fact that no case has yet been discovered in which it is demonstrably violated. On the other hand, many previously unknown phenomena of nature have been predicted by its aid, and in every instance subsequent experiment has borne out the prediction in every respect. For a short account of some of the better known objections that have been urged against the soundness of the "second law," consult the latter portion of Browne's translation of Clausius's 'Mechanical Theory of Heat.'

In studying the transformation of heat-energy into mechanical energy (or the reverse), it is customary to think of the conversion as being performed by a suitable type of heat-engine; for this conception helps to make the problem definite, so that the mind can readily grasp the principles involved. The imaginary engine is usually conceived to be perfect in construction, so as to run without friction and without losses by radiation or conduction. In fact, the material of which the engine is composed is assumed to be incapable of absorbing any heat at all. Some of its parts may, however, be assumed to be perfectly transparent to heat, and others to be absolutely opaque to it; and we may make such other extravagant assumptions as may be convenient for the discussion of the problem in hand, the only office of the imaginary engine being to assist the mind in the presentation and discussion of the essential facts, whatever those may be. These fictive engines are usually assumed, furthermore, to be "perfectly reversible," so that when, by the expenditure of mechanical power, they are forced to run backwards, all of the normal operations of the engine take place precisely as before, but in a contrary sense. If, for example, the engine, at some instant in its forward motion, absorbed a quantity Q of heat from an outside body whose temperature was T, then when the engine reaches the corresponding state in its reversed motion, it must give out this same quantity, Q, of heat, and must give it out again to the same body from which it originally abstracted it, and at the same temperature, T. An engine which fulfils all of these various conditions is called a "perfectly reversible engine"; or, more briefly, an "ideal engine."

Carnot's Theorem.— In 1824 Carnot gave a remarkable theorem (consult his 'Reflections on the Motive Power of Heat,' Thurston's translation), which may be stated in the following language: Of all the possible kinds of heat engine, which run by converting heat-energy into mechanical energy, and which take in their heat all at one given temperature and give out all that they do give out (if any) at another given temperature, there is none that is more efficient than the ideal, reversible engine; "efficiency" being defined as the fraction of the absorbed heat-energy that is converted into mechanical work. This theorem is of exceeding importance, as it holds true not only for the untold thousands of kinds of ideal engines that we might be able to think of at the present time, but also for any others that may depend upon principles of nature as yet undiscovered; always supposing that the two fundamental laws of thermodynamics, as stated above, are true. In Carnot's time, heat was believed to be a substance; and Carnot's proof of his theorem is based upon this view. After the newer conception of heat had been attained, however, Clausius proved that Carnot's theorem is capable of equally sound demonstration in accordance with the two thermodynamical laws now admitted. The proof is as follows: Let us assume that the theorem is false, and that there is some other engine, which we will designate as B, which is more efficient than some particular ideal reversible engine, A, which runs between the same two temperature limits. Let T_1 be the temperature at which both engines take in their heat, and let T_2 be the temperature at which each rejects such heat (if any) as it does not transform into work. Let H_1 and H_2, respectively, be the quantities of heat taken in and rejected, during a given time, by the reversible engine, A, and let H'_1 and H'_2 be the quantities taken in and rejected, respectively, by the other engine B. The quantities of heat that are transformed into work by A and B, respectively, are then $(H_1—H_2)$ and $(H'_1—H'_2)$; and the efficiencies are respectively $(H_1—H_2)/H_1$ and $(H'_1—H'_2)/H'_1$. The condition that we are assuming, in violation of the theorem, is that the efficiency of the engine B is greater than that of A; that is, $(H'_1-H'_2)/H'_1 > (H_1-H_2)/H_1$; or, what is the same thing, $H_1(H'_1-H'_2) > H'_1\ (H_1-H_2)$. Now suppose that the two engines are coupled together so that the engine B runs forward and drives the reversible engine, A, backward. Then A, owing to its reversibility, for every (H_1-H_2) units of mechanical work that it absorbs, takes in H_2 units of heat at the temperature T_2, and rejects H_1 units of heat at the higher temperature, T_1; while the other engine, B, for every $(H'_1-H'_2)$ units of mechanical work that it performs, takes in H'_1 units of heat at the higher temperature T_1, and rejects H'_2 at the lower temperature T_2. Now in the case supposed, where one of the engines drives the other one backward, the mechanical energy devoleped by the engine B is entirely absorbed by the reversed engine, A. Hence we have $(H'_1-H'_2) = (H_1-H_2)$; and this equation, taken in connection with the foregoing inequality, gives $H_1 > H'_1$. That is, the heat delivered by the doubled engine to the source whose temperature is T_1, is greater than the heat that is being withdrawn from that source; so that if we regard the doubled engine as a single machine, we have a case in which heat is passing, by its own natural tendency and without external compulsion, from a temperature T_2 to a higher temperature, T_1. But this is contrary to the second law of thermodynamics; and hence if that law is sound, it must be that no such engine as B exists. In other words, there is no engine which takes its heat all at a temperature T_1, and rejects what it does reject at a lower temperature T_2 which has a higher efficiency than the ideal reversible engine running between these same temperature limits. It will be observed that in case both of the engines are reversible, the foregoing proof can easily be made to show that neither one is more efficient than the other one. It follows, therefore, that all ideal reversible engines which take in no heat except at T_1, and reject none except at T_2, have the same identical efficiency; and this efficiency can, therefore, depend upon nothing but the two temperatures T_1 and T_2. In the language of mathematics, the efficiency of an ideal reversible engine which runs as here described is a "function" of the temperatures at which heat is absorbed and rejected, and of nothing else. In the foregoing demonstration it was assumed that all of the heat taken in by the engine B is either transformed into mechanical energy or rejected at the temperature T_2. If the engine B is of such a kind that this condition is not fulfilled, by reason of the engine losing some of its heat at temperatures intermediate to T_1 and T_2 (or by reason of any other imperfaction in design or construction), then the theorem is still true; for the assumption that we have made above is the one that is least favorable to the demonstration.

Absolute Temperature.— Let us consider an ideal, reversible engine, which in each unit of time takes in H_1 units of heat at the temperature T_1, and rejects H_2 units of heat at the temperature T_2. Then the efficiency of the engine is $(H_1-H_2)/H_1$; and this (as we have seen) must be equal to some function of T_1 and T_2. It will be more convenient, however, to write the efficiency in the form $1-(H_2/H_1)$; which is obviously permissible. Since this is a function of the two temperatures, so also is H_1/H_2; and we may write $H_1/H_2=f(T_1, T_2)$. Now H_2, being the heat rejected by the given engine at the temperature T_2, may be used again in a second ideal reversible engine, which we may assume to take its heat at T_2, and to reject what it does reject (if any) at some still lower temperature, T_3. The second engine, considered separately, would give a second equation entirely analogous to the one already written; and we should have $H_2/H_3=f\ (T_2, T_3)$. But we might consider the two engines, coupled together, to constitute a single ideal reversible engine, taking in a quantity H_1 of heat at T_1, and rejecting a quantity H_3 at the temperature T_3. From this point of view we could write $H_1/H_3= f\ (T_1, T_3)$. But if we multiply H_1/H_2 by H_2/H_3, we obtain H_1/H_3; and hence we see that the function f must be of such a nature that we have the identical relation

$$f\ (T_1, T_2).\ f\ (T_2, T_3)=f\ (T_1, T_3),$$

whatever the values of T_1, T_2 and T_3. Examination of this equation will show that the disappearance of T_2 by the multiplication of the two terms in the first member involves that the function f shall be of the form

$$f\ (T_1, T_2)=F(T_1)/F(T_2).$$

Hence we have the general relation

$$H_1/H_2=F(T_1)/F(T_2);$$

H_1 and H_2 being, respectively, the quantities of heat absorbed and emitted by any ideal reversible engine, at the temperatures T_1 and T_2; the engine being supposed to absorb no heat except at T_1, and to reject none except at T_2. The algebraic form of the function $F(T)$ will depend, evidently, upon the kind of thermometer that is used in defining the temperature T; but whatever the form of the function may be, its numerical value will always be the same for any fixed temperature, no matter what the nature of the thermometric scale may be, from which it is obtained. This follows from the fact that the last equation above must always hold true, and H_1 and H_2 are not dependent in any way upon any thermometric scale. The independence of the numerical value of $F(T)$ of all arbitrary thermometric scales suggested to Lord Kelvin the possibility of computing the numerical values of the function, and basing upon these values a new thermometric scale, which he called the "absolute scale," since its readings would be "absolute," in the sense of being independent of the properties of any particular kind of matter. Preliminary investigations of the quantities of heat absorbed and rejected by an ideal reversible engine in which the work is performed by the expansion of air indicated that the numerical values of the function $F(T)$ can be expressed in the form $F(T)=T+C+x$, when T is the temperature according to the normal, constant-volume air thermometer (see THERMOMETRY); C being a constant and x a small variable term, whose value, between the freezing and boiling points of water, never exceeds a very small fraction of a degree. For the details of the method by which the numerical values of the function $F(T)$ are evaluated, reference must be made to special works on thermodynamics, and to papers on the subject of absolute temperature. (See HEAT). It is sufficient, here, to say that by the application of the two fundamental principles of thermodynamics to the phenomena that occur when a mass of gas changes its state by an infinitesimal amount, it is possible to deduce a differential equation which, when integrated for the conditions that prevail in a constant-volume thermometer filled with the kind of gas under consideration, will give a finite relation between the scale of the gas thermometer and the "absolute scale." One of the most important terms in this differential equation relates to the change of internal energy experienced by a gas when the volume of the gas changes while the temperature remains constant. In order to evaluate this term, special experiments are necessary, in which the gas is caused to change its volume, while the temperature is constant. Joule and Kelvin were the first to devise an experiment capable of yielding accurate results of this character, and the work that they did along these lines more than half a century ago has never yet been adequately verified, although it constitutes the only secure basis of all that we know, to-day, about the numerical corrections that must be applied to the readings of a gas thermometer, in order to reduce those readings to the absolute scale. In their experiments, the gas was caused to expand through a porous plug, and the quantity of energy that must be added to it in order to prevent any change of temperature by this "free expansion" was determined by calculation. It is impossible to enter, in this place, upon the details of their work; but the writer of the present article has made a careful examination of the data given by Joule and Kelvin, and he finds that when the temperature is measured by the normal constant-volume hydrogen or nitrogen thermometer, in which the pressure at the freezing point of water is that due to one metre of mercury, and which is graduated according to the Centigrade scale so as to read 0° at the freezing point of water and 100° at the boiling point, (1) there must be a constant term of 273.10° added to the reading of the thermometer in order to obtain the reading of the instrument on the absolute scale, and also (2) a small variable term, whose values are given in the second and third columns of the accompanying table.

TEMPERATURE BY GAS THERMOMETER	Variable part of the correction to reduce to the absolute scale	
	Nitrogen thermometer	Hydrogen thermometer
0° C.	0.000°	0.000°
10°	— 0.003	+ 0.006
20°	— 0.006	+ 0.006
30°	— 0.007	+ 0.007
40°	— 0.008	+ 0.004
50°	— 0.008	0.000
60°	— 0.007	— 0.003
70°	— 0.006	— 0.006
80°	— 0.004	— 0.007
90°	— 0.002	— 0.005
100°	0.000	0.000

The corrections here given are different from those usually quoted, but it is believed that they are more accurate. In the case of the hydrogen thermometer, it will be observed that from 0° C. to 50° C. the corrections are positive, while from 50° C. to 100° C. they are negative. However improbable this change of sign may appear, it is certain that the differences between the readings of the hydrogen and nitrogen thermometers, as deduced from the corrections here given, correspond very faithfully with the actual differences as observed at the International Bureau of Weights and Measures at Paris. Owing to the smallness of the variable part of the correction, it is usualy, in writings upon engineering topics and upon thermodynamics generally, to take note only of the large constant term that is to be added, and to treat absolute temperature as though it were identical with the temperature as read from a constant-volume gas thermometer, save for the addition of the constant, 273.10° C. In other words, if t is the absolute temperature corresponding to a given reading T on the scale of a gas thermometer, it is customary to assume that $t=T+273.10°$, if the thermometer is graduated on the Centigrade plan, or $t=T+459.58°$, if the graduation is according to Fahrenheit.

Students of thermodynamics are often greatly confused by the introduction of the idea of «entropy»; and while this subject requires the higher mathematics for its adequate discussion, a few words may be given to it here. When a body whose state at any given instant is completely defined by two independent variables, undergoes any infinitesimal but reversible change on account of corresponding infinitesimal changes in the two defining variables, it will, in general, absorb or reject a certain infinitesimal amount of heat, and it is easy to form a differential equation of the first order and degree, which will express the quantity of heat that is absorbed; the expression being taken negative, if there is rejection of heat instead of absorption. We know, from the theory of differential equations, that the equation so formed can always be multiplied by some factor (the «integrating factor») which shall cause it to become an exact differential of some function of the variables whose differentials it contains; but, so far as pure mathematics is concerned, it is impossible to say, in advance, what that integrating factor will be, or what the nature of the function may prove to be, of which the modified expression is the exact differential. By the aid of the second law of thermodynamics, however, it may be shown that the reciprocal of the absolute temperature at which the infinitesimal transformation takes place is always an integrating factor of the differential equation in question. In other words, having written the differential expression for the quantity of heat absorbed by the body, we know that we only have to divide it by the absolute temperature of the body, in order to cause it to become the exact differential of some function of the variables. The function whose existence is thus indicated is called the «entropy» of the body, and in the study of thermodynamics this function is a very convenient thing, because its introduction simplifies the treatment of many problems. The main difficulty that students experience in connection with it is the difficulty of assigning to «entropy» any precise physical significance. It is probably better not to try to give any physical interpretation of this sort; for it is sufficient for many purposes merely to recognize the existence of the function, the very fact of its existence suggesting certain mathematical transformations which are exceedingly useful. The suggestion has sometimes been made, that it may prove to be possible to devise an instrument which shall enable us to measure the value of the entropy of a body directly, just as a thermometer measures the value of a temperature. If this could be done, the imagination of the student of thermodynamics would doubtless be greatly assisted; but it does not appear that the hope of discovering an instrument of this sort is at all well founded.

In studying the thermodynamic behavior of a body, the state of the body is defined by giving as many of its measurable attributes as may be necessary in order to fix the condition of the body absolutely. These measurable attributes are represented by letters, and are taken as independent variables. Then, by treating these independent variables by known mathematical methods, we can deduce certain conclusions with regard to the behavior of the body itself. Theoretically, there is no reason why the number of independent variables may not be as great as we please; but in all of the more important applications of thermodynamics it is found to be sufficient to take two independent variables. In the case of a gas, for example, it is usually sufficient to take two such variables, provided the gas is in a quiescent condition and homogeneous throughout. When the possibility of internal motions is admitted or the gas differs in composition or in other respects in its different parts, it is necessary to take more than two variables; but these cases will not be considered in the present article. (Gibbs, in his classical papers on the 'Equilibrium of Heterogeneous Substances,' published in the 'Transactions of the Connecticut Academy of Sciences' just previous to 1880, discussed many of the problems that arise when the composition of the substance under consideration departs from uniformity and homogeneity in any respect). Some latitude is permissible as to the variables that are selected for representing the state of the gas, but for the present we shall consider the state as being thoroughly defined when we know the pressure, P, that it exerts upon each unit of area of the wall of its containing vessel and also the volume, V, occupied by each unit of its mass. Other attributes of the gas may indeed vary, as well as P and V; but if P and V are really sufficient to define the state of the gas completely, then these other attributes that are capable of variation at the same time must all be expressible as functions of the two variables P and V. The temperature of the gas is one of the most notable physical attributes which is capable of variation; and it follows that there must be a relation connecting the temperature, T, with the variables P and V. This equation, which is called the "characteristic equation" or sometimes the "elastic equation," may be written, tentatively, in the general form $T=F(P, V)$. While we know that an equation of this nature must exist, we do not know the exact form of the function F for any actual substance. For gases, however, we know its approximate form, throughout certain ranges of the variables P and V. Robert Boyle showed that so long as the temperature of the gas is kept constant and the gas is not too highly compressed nor too near to its point of liquefaction, the volume varies very nearly as the reciprocal of the pressure, and Charles discovered (to express it in modern language) that so long as the pressure upon the gas remains constant, the volume is nearly proportional to the absolute temperature. Taking these two laws into account, it is evident that the form of the function F must be such that, for such values of the variables P and V as prevail under the conditions in which the laws of Boyle and Charles are nearly true, we must have

$$T=kPV, \text{ or } P=\frac{RT}{V};$$

T being the absolute temperature and k and R being constants whose values are to be determined by experiment. For many practical purposes, this relation between P, V and T is sufficiently exact. When the gas is highly compressed, however, or when it is near to the point of liquefaction, the foregoing equation is found to depart very materially from the facts as experimentally observed. Many attempts have been made to find a more general law connecting the temperature, pressure and volume, and such equations have been given by Rankine, Van der Waals, Clausius, Sarrau and other writers. As the equation of Van der Waals has been of special service and has figured to a great extent in the thermodynamical literature of recent times, it may be cited as an example of the attempts that have been made to find a superior form of elastic equation. The equation in question has the form

$$P=\frac{RT}{V-b}-\frac{a}{V^2},$$

where R, T, V and P have the same significance as before, and a and b are very small constants. If a and b are both zero, this equation reduces to the form previously given, and the same is true if V is very large indeed (that is, if the gas is very rare), since in that case the effects of the small constants a and b are negligible. If we assign to T any constant value that we please, we may, from Van der Waals' equation, trace all the possible relations that P and V can have, at this one temperature. That is, when a, b and R are known, and we have assigned a fixed arbitrary value to T, we may then select any number of values of V, and compute the value of P that corresponds to each one of them. If we plot the values so

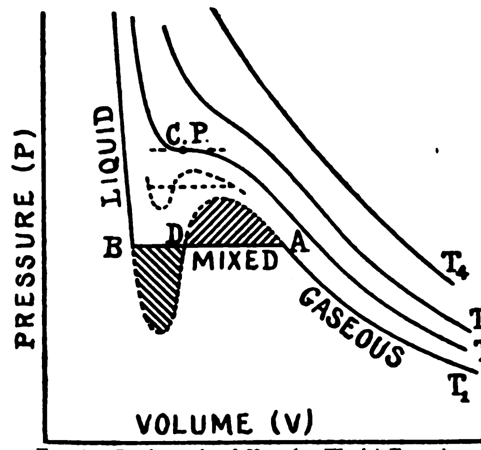


FIG. 1.— Isothermals of Van der Waals' Equation.

computed, by laying off horizontal distances to represent the values of V, and vertical distances to represent the corresponding values of P, we shall obtain a series of points representing the various states that the gas is capable of assuming, while T keeps its fixed value, and if we make the calculated points numerous enough, we may draw through them a curved line, which may be taken to represent the continuous series of states through which the gas passes, as the pressure is continuously varied, while the temperature remains constant. Such lines are called "isothermals," on account of the constancy of the temperature along them. Several such lines, as computed for as many different values of T from Van der Waals' equation, are shown in Fig. 1. If the temperature is high (as at T_4), the isothermal line may be indistinguishable in form from the corresponding line as computed from the elastic equation of Boyle and Charles. If, on the other hand, the temperature is sufficiently low, as is indicated at T_1, the isothermal line will have a very different shape. To trace the significance of this shape, let us begin at the right-hand end of the isothermal T_1, and see what happens when the pressure upon the gas is continuously increased. As the pressure grows greater, the volume of the gas diminishes; but there is no notable change of any other sort until a certain point A is reached. When this point is attained, any attempt to further increase the pressure merely results in the condensation of a part of the gas; the pressure remaining constant (as indicated by the horizontal line ADB) until, at B, the gas is entirely condensed into the liquid form. Further application of pressure then causes but a slight reduction of volume; a fact which is indicated by the steepness of the isothermal line above B. We have here described what actually happens when the gas is compressed along the isothermal T_1; but it must be noted that the plot of this isothermal from Van der Waals' equation does not give a straight part, ADB, but a reversed curve between A and B, as indicated by the dotted line. If we could actually make the gas follow this dotted line, we could cause it to pass from the gaseous condition into the liquid condition, without any discontinuity in state; that is, in such a manner that it would never be partly liquid and partly gaseous, and so that we should not be able to see when the conversion from one state to the other took place. It can be shown, however, that the states of the gas which correspond to the dotted part of the isothermal are essentially unstable, so that the attempt to make the gas follow the dotted portion of the theoretical isothermal is like trying to balance a pyramid upon its point. The line ADB which the gas actually follows in preference to the double loop, is in such a position that the areas of the two shaded loops are equal, as was first shown by Maxwell. A portion of the dotted loops in the immediate vicinity of A and B can be actually realized in the laboratory, by careful experiment; but the instability speedily becomes too marked to permit of the experiments being carried far. At temperatures intermediate between T_1 and T_4 the isothermals have a character intermediate between those shown for those temperatures. As we proceed upward from T_1, the loops on the isothermals grow less and less pronounced, as is indicated by the partial, dotted isothermal, and we presently arrive at one particular isothermal, T_3, where the loops just cease to exist. At any temperature higher than T_3 it is, therefore, impossible to liquefy the gas by the application of any pressure whatever, no matter how great. Hence the temperature T_3 is the «critical temperature» of the gas. (See CRITICAL POINT). There is one point on this critical isothermal (marked «$C. P.$»), at which the isothermal is precisely horizontal and where it also has a point of inflection; and this point corresponds to the critical point of the gas; its temperature being the critical temperature, its volume the critical volume and its pressure the critical pressure.

Although gases obey the characteristic equation of Boyle and Charles very closely when they are not too highly compressed and not too near to condensation, there is no gas which obeys it rigorously under all conditions. It is often convenient, however, to assume the existence of a gas of this sort, for the purpose of illustrating general principles, or of obtaining approximate solutions of thermodynamical problems; and the ideal (but non-existent) gas which fulfils the relation of Boyle and Charles absolutely and under all circumstances is commonly called a «perfect gas,» though «ideal gas» would appear to be a preferable name. In applying the conception of a perfect gas, it is customary to assume the further condition that when a gas of this sort changes its volume at constant temperature, the heat that it absorbs is exactly equivalent to the external work that the gas does, in expanding against the external pressure that the containing vessel exerts upon it. In other words, it is customary to assume that the perfect gas, in addition to obeying the laws of Boyle and Charles perfectly, is also so constituted that its internal energy depends upon nothing but the temperature of the gas. The characteristic equations of Van der Waals and others are decided improvements upon the equation of Boyle and Charles, and they represent, very well, the nature of the phenomena that occur in a gas in the vicinity of the critical point. None of them takes any account, however, of the fact that a body is capable of existing in the solid state, as well as in the liquid and gaseous states; and the first characteristic equation complete enough to take the solid state into account also, has yet to be proposed.

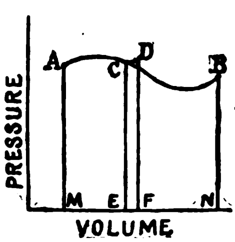


FIG. 2.

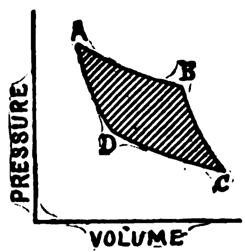


FIG. 3.

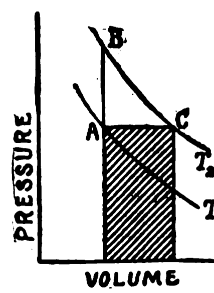


FIG. 4.

When a body passes from one condition of pressure and density to another, it either absorbs or emits heat, unless certain special conditions are fulfilled. To avoid circumlocution, we may speak of it as always «absorbing» heat; the emission of heat being considered to be merely a case of negative absorption. Suppose, for example, that a body is in the state corresponding to A, in Fig. 2; and for definiteness let us suppose that the body under consideration is a gas, although the reasoning will apply equally well to a liquid or to a homogeneous, isotropic solid. The height of A above the horizontal reference line then represents, on some convenient scale, the pressure to which each unit of the bounding surface of the gas is exposed; and the distance of A from the vertical reference line at the left corresponds, upon some other convenient scale, to the volume occupied by a unit mass of the gas. Now if the gas be caused to pass from the condition represented by A to that which is represented by B, by passing through all the intermediate conditions that are represented by the points that are intermediate to A and B on the line ACB, the gas is said to pass from the state A to the state B along the «path» ACB. In general a change of this sort will be accompanied by an absorption of heat; the heat which is absorbed being partly expended in increasing the internal energy of the gas, and partly in the performance of external work. It is a consequence of the first law of thermodynamics that the change in the internal energy of the gas is entirely independent of the shape of the path ACB, and depends only upon the positions of the points A and B. That portion of the absorbed heat which goes to increase the internal energy of the gas, therefore, depends upon nothing but the positions of A and B. The case is different, however, with that portion of the absorbed heat which is consumed in the performance of external work. Consider, for example, the state of the gas at the point C. The pressure upon the gas, per unit of area of the containing vessel, is represented by the vertical line CE; and when the volume of the gas increases by the slight amount EF, the external work that the gas does is represented by the product of the pressure and the increase in volume; that is, it is represented by the area of the little rectangle $CDFE$. We may regard the area $ACBNM$ as made up of an infinite number of infinitesimal rectangles, each of which is typified by the little rectangle that is shown; and hence it follows that the total quantity of external work done by the gas as it passes from the condition A to the condition B, along the path ACB, is represented by the area included between the curve ACB and the straight lines AM, MN and NB. Obviously this area depends upon the form of the path ACB; and hence the external work that is done by the gas also depends upon the form of that path, and so also does that part of the heat absorbed along ACB, which is consumed in performing this work.

When a gas (or other body) describes a *closed* path, such as is shown in Fig. 3, and returns finally to its original state, then the internal energy of the gas also returns to its original value; and the total quantity of heat that is absorbed by the gas during its passage around the closed path is therefore represented entirely by the external work that the gas does. That is, it is represented by the area of the closed path, as shown shaded in Fig. 3. A closed path of this sort is called a «cycle,» and the consideration of cycles of various kinds is very important in many branches of thermodynamical reasoning. If AB and DC, in Fig. 3, represent isothermal lines, and AD and BC represent adiabatic lines (that is, lines along which there is no absorption or rejection of heat by the gas), then the cycle $ABCDA$ is called a «Carnot cycle,» because it is the kind of a cycle that Carnot imagined his ideal, reversible engine to describe. (See Carnot's principle, enunciated in the earlier part of this article).

When a gas is heated from a temperature T_1 to another temperature T_2, the quantity of heat absorbed in the process will depend upon the precise way in which the passage from one of these temperatures to the other is effected. Thus let A, in Fig. 4, represent the initial state of the gas, and let the curved lines, T_1 and T_2, represent the isothermals corresponding to the temperatures T_1 and T_2. If we cause the gas to pass from the isothermal T_1 to the isothermal T_2 along the horizontal line AC, we are heating the gas while its pressure remains constant; and if we cause it to pass from T_1 to T_2 along the vertical line AB, we are heating it while its volume remains constant. If the difference in temperature between T_1 and T_2 is one degree, and the mass of the gas is (as we have already assumed) unity, then the quantity of heat absorbed along AB is the «specific heat at constant volume,» and the quantity absorbed along AC is the «specific heat at constant pressure.» That these two specific heats are really different will be evident from the fact (1) that the internal energy of the gas in the states B and C are not necessarily the same, unless the gas is a «perfect gas»; and also from the fact (2) that the heat that is absorbed along the path AC has to be partially expended in doing the external work represented by the shaded area; while along the path AB there is no external work done.

The fact that in an ideal reversible heat engine the efficiency does not depend at all upon the nature of the substance whose expansion does the work, is sometimes hard for the beginner in thermodynamical reasoning to understand, for the reason that objections occur to him which appear to controvert the principle, and to be themselves unanswerable. There is an answer, however, to every objection that can be urged. One of the commonest of the difficulties is this: In a steam engine, water is pumped into the boiler, and is then evaporated by the expenditure of a large amount of heat. The steam is next passed to the cylinder of the engine and expanded, after which it is turned into the condenser and re-converted into water. The quantity of heat which is expended upon the water in merely converting it into steam (and which is known as the «latent heat of vaporization») appears to be wasted in large measure, because the greater part of it is not converted into mechanical energy by the engine, but is merely rejected into the condenser. Engines have been designed and built, in which the water that is commonly used is replaced by some other liquid (such as ether or carbon disulphide) which has a much smaller latent heat of vaporization, in the belief that this apparently large source of loss could be avoided; but such engines have invariably proved disappointing, any trifling superiority that they may have shown from time to time being attributable to other causes than the smaller latent heat of vaporization of the working fluid. The reason for this is, that there is an intimate relation between the pressure of a saturated vapor at a given temperature, and the latent heat of vaporization of the liquid. This relation is sometimes known as the «second thermodynamic relation,» and sometimes as «Clapeyron's equation.» The elucidation of this matter requires a knowledge of the infinitesimal calculus, and reference must be made for it to the standard works on thermodynamics. Much of the practical experimental work that has been done upon the hot-air engine has probably been inspired by ignorance of the existence, or at least of the significance, of this «second thermodynamic relation.» See HEAT; SPECIFIC HEAT; THERMOMETER; THERMOMETRY; GASES, KINETIC THEORY OF; and other similar articles in this encyclopedia.

Bibliography.— Bryan, 'Thermodynamics'; Clausius, 'Mechanical Theory of Heat' (Browne's translation); Findlay, 'The Phase

Rule'; Mach, 'Principien der Wärmelehre'; Magie, 'The Second Principle of Thermodynamics'; Maxwell, 'Theory of Heat'; Poincaré 'Thermodynamique'; Preston, 'Theory of Heat'; Tyndall, 'Heat as a Mode of Motion.'

ALLAN D. RISTEEN,
Director Technical Research, The Travelers Insurance Company, Hartford, Conn.

THERMO-ELECTRICITY. If an electrical circuit is constructed partly of one metal and partly of another, and one of the points of junction between the dissimilar metals is heated while the other is kept cool, a current of electricity will be caused to flow in the circuit. This fundamental fact was discovered by Seebeck in 1821. The electricity thus generated is not in any wise different from that which is generated by an ordinary galvanic battery; but on account of its mode of production it is called «thermo-electricity.» The electromotive force that is set up in a circuit under the circumstances here described is always quite small, and its intensity depends (1) upon the nature of the metals of which the circuit is composed, (2) upon the difference in temperature between the two junctions where the dissimilar metals come together and (3) upon the average temperature of these junctions. For the sake of definiteness, let the two metals of which the circuit is composed be designated by the letters X and Y. The phenomena of thermo-electricity may then be described in the following mathematical language: It is known from experiment that when the two metals X and Y are brought together so that their point of contact has the temperature T, an electromotive force exists between the two, which tends to send a current (say) from X into Y; and it is also known that the magnitude of this electromotive force can be expressed as a parabolic function of the temperature, T. Thus if E is the electromotive force in question, the facts of experiment can be adequately expressed by a relation of the form $E=a+bT+cT^2$; where a, b and c are constants whose values depend upon the natures of the metals X and Y. In the actual circuit there are necessarily two junctions across which electromotive forces of this character exist. Let the temperatures of these junctions be respectively T_1 and T_2. Then the foregoing formula shows that across the junction whose temperature is T_1 there is an electromotive force of intensity, $E_1=a+bT_1+cT^2_1$, tending to send a current from X into Y; and across the junction whose temperature is T_2 there is a similar electromotive force of intensity

$$E_2=a+bT_2+cT^2_2$$

also tending to send a current from X into Y. These electromotive forces being opposed to each other, so far as the production of a current around the circuit is concerned, the effective electromotive force around the circuit is the difference between E_1 and E_2; and if we denote this effective electromotive force by the letter F, we have

$$F=E_2-E_1=b\ (T_2-T_1)+c(T^2_2-T^2_1),$$

or

$$F=(T_2-T_1)\ [b+c(T_2+T_1)].$$

From this last equation it is evident that so long as the average temperature of the two junctions is constant (or, in other words, so long as T_2+T_1 is constant), the electromotive force will be proportional to the difference in temperature between the two junctions. But it is also evident that when the average temperature of the two junctions is such that the relation

$$b+c(T_2+T_1)=0$$

is fulfilled (or, in other words, when the average temperature of the two junctions is numerically equal to $-b/2c$), there will be no thermo-electromotive force in the circuit (and, therefore, no current), no matter what the difference in temperature between the two junctions may be. This average temperature, for which there is no thermo-electric effect in a circuit, has a definite value for every pair of metals, and is known as the «neutral temperature» for that pair. The values of the constants b and c, in the foregoing formulæ, could be determined experimentally, and recorded in tabular form for various pairs of metals. It is usual, however, to record the experimental data in a somewhat different manner, as we proceed to explain. If the average of the two temperatures T_1 and T_2 be denoted by T_0, then the formula for the effective electromotive force, F, may be written

$$F=(T_2-T_1)\ (b+2cT_0).$$

The constants b and c refer, it will be understood, to a particular *pair* of metals; but it is found that their values can be satisfactorily represented as the differences between constants which can be stated for the two metals separately. Thus b can be expressed in the form $b=B'-B''$ and $2c$ can be expressed in the form $2c=C'-C''$; B' and C' being constants whose values depend solely upon the metal X, and B'' and C'' being constants whose values depend, in a similar manner, solely upon the metal Y. The expression for the effective electromotive force F can, therefore, be written thus:

$$F=(T_2-T_1)\ [(B'-B'')\ +\ (C'-C'')\ T_0].$$

The values of the constants B and C for the different metals vary somewhat with the physical conditions of the metals; but the data given in the accompanying table will show the general nature of these constants, and will also suffice to represent, with some degree of approximation, the actual magnitude of the thermo-electric effects that may be expected from circuits composed of the metals there represented. In applying this table, temperatures are supposed to be expressed on the ordinary Centigrade scale, which defines the freezing point of water to be 0°, and the boiling point to be 100°; and the results are expressed in hundred-millionths of a volt, so that to reduce them to volts it is necessary to divide them by 100,000,000.

To illustrate the use of this table, let us compute the electromotive force of a circuit composed of iron and copper, when one of the junctions is kept at 0° C., and the other at 100° C. For iron we have $B=+1734$ and $C=-4.87$; and for copper we have $B=+136$ and $C=+0.95$. Hence we see that for this pair of metals $b=+1734-136=+1598$, and $2c=-4.87-0.95=-5.82$. The thermo-electromotive force in the circuit is therefore,

$$F=(T_2-T_1)\ \ (1598-5.82T_0).$$

But we have assumed that $T_2=100°$ and $T_1=$

0°; hence $T_2 - T_1 = 100$, and $T_0 = 50°$, and we have $F = 100(1598 - 5.82 \times 50) = 130{,}700$. Dividing this by 100,000,000 to reduce it to volts, the final conclusion is, that a thermo-electric couple of the kind described will give an electromotive force of about 0.00131 of a volt (in round numbers). To find the "neutral point" of an iron-copper couple, we merely have to set the expression $1598 - 5.82T_0$ equal to zero, and solve the equation for T_0. Proceeding in this manner, we find that the desired neutral temperature is 274° C.

THERMO-ELECTRIC CONSTANTS OF METALS.

METAL	B	C
Iron	+ 1734	— 4.87
Steel	+ 1139	— 3.28
Soft platinum	— 61	— 1.10
Hard platinum	+ 260	— 0.75
Magnesium	+ 244	— 0.95
German silver	— 1207	— 5.12
Zinc	+ 234	+ 2.40
Silver	+ 214	+ 1.50
Gold	+ 283	+ 1.02
Copper	+ 136	+ 0.95
Lead	0	0.00
Tin	— 43	+ 0.55
Aluminum	— 77	+ 0.39

Nickel is not included in the foregoing table, because its behavior is anomalous. From −18° C. to 175° C. its constants are $B = -2204$ and $C = -5.12$; but a short distance above 175° C. their values change profoundly, so that between 250° C. and 310° C. we have $B = -8449$ and $C = +24.1$. Above 340° C. we have, for this metal, the values $B = -307$ and $C = -5.12$. Antimony and bismuth are commonly used as the two metals in experimental thermo-electric circuits, since they yield an electromotive force which is larger than is obtainable under similar conditions by other metallic pairs. The thermo-electric constants of antimony and bismuth do not appear to have been determined with precision, however. When the average temperature of the two junctions (T_0) is about 20° C., the values of $B + CT_0$ are approximately as follows: Bismuth, pressed commercial wire, −9700; bismuth, pure pressed wire, −8900; bismuth crystal, axially, −6500; bismuth crystal, equatorially, −4500. Antimony, pressed commercial wire, +600; antimony, pure pressed wire, +280; antimony crystal, axially, +2260; antimony crystal, equatorially, +2640.

When a thermo-electric couple is generating an electrical current, heat is absorbed at the hot junction, and given out at the cold one. If an electric current is caused to flow across the junction of any two dissimilar metals, heat is either evolved or absorbed at the junction; and if an evolution of heat is observed when the current flows across from the metal X to the metal Y, there will be an absorption of heat when the current is made to flow from Y to X. This phenomenon, which was discovered by Peltier, is known as the "Peltier effect." Lord Kelvin showed that in a thermo-electric circuit the reversible heat effects are not confined to the junctions themselves. He showed, in fact, that when an electrical current is caused to flow through a wire that is locally heated by a gas flame or otherwise, the current tends to cause a displacement, along the length of the wire, of the point of maximum temperature. The effect may be illustrated by thinking of the wire as a tube conveying a stream of some real fluid; the fluid taking up more or less of the heat, and carrying it along in such a way as to shift the point at which the temperature is greatest. The analogy is imperfect, however, because in the case of electricity the heat travels with the current in some metals, and against it in others. This phenomenon (which is known as the "Thomson effect") has an important bearing upon the theory of thermo-electricity, because in a thermo-electrical circuit the temperature is necessarily variable from point to point, and, therefore, the "Thomson effect" may (and in fact does) modify the phenomena considerably. The effect is zero in lead, but in nearly every conductor it is quite sensible. The consequences of the "Thomson effect" are discussed in two papers in the first volume of Lord Kelvin's 'Mathematical and Physical Papers.'

When a circuit contains several thermo-electric couples, with their successive junctions alternately heated and cooled, the total electromotive force that is produced is sensibly equal to the sum of all the electromotive forces that the several couples would produce, if each existed separately. Advantage is taken of this fact in the instrument known as the "thermo-pile," which consists of a series of small bars of antimony and bismuth (often about 25 pairs altogether), disposed side by side so as to form an approximate cube and insulated from one another by strips of paper or other non-conductor. These bars are soldered together at the ends so that a current, in order to traverse the system, must pass back and forth through alternate bars of bismuth and of antimony; the passage of the current from bismuth into antimony being always effected (let us say) at the right hand end of the little pile of bars, while the passage from antimony into bismuth is always effected at the left hand end. The two free ends of the thermo-pile being connected by a wire, a current of electricity flows through the circuit so formed, when either of the surfaces containing the soldered junctions is warmed, while the opposite one is kept cool. This instrument is used to a considerable extent for the detection and even for the approximate estimation of radiant heat; the current that it produces and which is measured by a delicate galvanometer in the external part of the circuit being taken as the index of the amount of the radiation. (Consult Tyndall, 'Contributions to Molecular Physics in the Domain of Radiant Heat'). The thermo-pile was invented by Nobili, but it was so greatly improved by Melloni that it is commonly credited to him.

Many attempts have been made to construct a thermo-electric combination that would yield a current of electricity intense enough to be of commercial utility; but while such attempts have been partially successful, there is no great reason to suppose that thermo-electric generators will ever be of much practical value. The difficulties are partly structural and partly theoretical. In order to realize any considerable electromotive force, the number of elements must be large; and the experience heretofore has been that a complicated thermo-pile is not particularly durable. Even if this objection can be overcome, there remains the serious one that there are theoretical reasons, based upon thermodynamics (q.v.), for believing that the efficiency of the thermo-pile, as an instrument for converting heat energy into electrical energy, can never be high. In a particular case that was investigated by Lord Rayleigh, the maximum possible efficiency was found to be 6 per cent; and it is not likely that an efficiency materially greater than this will ever be actually attained with a thermo-pile that is large enough and durable enough to be of commercial value.

ALLAN D. RISTEEN,
Director of Technical Research, The Travelers Insurance Company, Hartford, Conn.

THERMOGRAPH (Greek, «heat-writing»), any form of self-registering thermometer (q.v.), by which an automatic record of variations of temperature is kept. Many different types of thermograph have been made, of which the following may be especially noted: (1) Photographic thermographs, in which the position of the mercury thread in an ordinary thermometer is photographed upon a moving sensitive film, either continuously or at short intervals of time; the moving sensitive film being actuated by clockwork, so that the time at which any given impression was made can be nicely determined. (2) Metallic-strip thermographs, in which a recording pen is actuated by a strip of metal composed of two substances of differing expansibility, riveted or soldered together. When a strip of this kind is heated, one of its sides expands more than the other, and the result is that the strip becomes curved by an amount which serves as a measure of the temperature to which the strip has been exposed. The pen which makes the record moves radially on a disc of paper which is caused to revolve at a steady rate by means of clockwork. (3) Electric-contact thermographs, in which a fine platinum wire is caused to descend, at intervals, into the open upper end of the capillary tube of a sensitive mercurial thermometer. When the wire touches the mercury column, it completes an electrical circuit, and by this means the position of the mercury thread in the thermometer is recorded. (4) The manometric thermograph, in which the pressure in a closed vessel filled with a gas is taken as the index of the temperature; the pressure being recorded automatically, and the temperature being afterward inferred from the recorded pressure, by means of a theoretical formula, or else by direct comparison of the instrument, at different temperatures, with a standard thermometer. (The pressure of an isolated mass of gas of this kind is known to be sensibly proportional to the absolute temperature of the gas, so long as the volume is kept constant).

THERMOMETER (Greek «heat-measurer»), an instrument for determining the temperatures of bodies. The general problem of thermometry is considered, in this encyclopedia, under the heading THERMOMETRY; and the present article will be devoted mainly to the consideration of the common mercury-in-glass form of the instrument, and to certain of its modifications. The mercury-in-glass thermometer depends for its action upon the fact that mercury expands about seven times as much as glass, for a given rise in temperature; so that when mercury is enclosed in a glass vessel, its apparent expansion is quite considerable. The mercury-in-glass thermometer consists essentially of four parts, these being (1) the mercury, (2) the spherical or cylindrical bulb of glass which contains it, (3) the fine tube which is attached to the bulb and which serves to make the expansion of the mercury evident, and (4) the graduated scale which is affixed to the capillary tube and from which the indications of the instrument are read. In the manufacture of thermometers which are intended for accurate work, the mercury is carefully purified by filtration through leather under pressure, and by subsequent distillation, and, in many cases, by chemical treatment also; and immediately before the mercury is placed in the thermometer it should be boiled so that it may be rendered free from moisture and from air. In the manufacture of the capillary stems of thermometers, some kind of glass which experience indicates to be adapted to this end is melted and the operator takes up a ball of it on the end of his blowpipe, blowing it out gradually and adding more glass to the mass from time to time. When the ball of molten glass has thus been brought to a convenient size, a second workman attaches his blowpipe to it also, and the two, still blowing, walk apart, so that the sphere of glass is drawn out into a very long and fine tube, which, when it has cooled, is cut into lengths and annealed. The calibre of each of these lengths is subsequently measured under the microscope, so that the instrument maker may know how large a bulb must be attached to each piece, in order that the degree-spaces on the finished thermometer may be of approximately the desired size. The bulb of the thermometer is usually made of a different kind of glass from the stem; and the process of making it consists simply in fusing to one end of the open stem a knob of special glass and then blowing it to size through the stem. In thermometers that are to be used for accurate scientific work, the bulbs should always be made of one of the three kinds of glass that are respectively known as «verre dur,» Jena 16^{III} and Jena 59^{III}. The first of these is a French glass, which has been demonstrated to be peculiarly adapted for use in thermometer bulbs, by the elaborate experiments made at the International Bureau of Weights and Measures, at Paris. The other two are made at Jena, Germany, and have been similarly proved to be adapted for use in accurate thermometers, by the experiments made at the Reichsanstalt, in Berlin. Since 1917 American glasses are manufactured that are well suited to the construction of accurate thermometers; but the problem to be solved is a difficult one and it will require much study and experiment. The stem and bulb of the thermometer being thus completed, the next step consists in cleaning them thoroughly on the inside. For this purpose they are washed out with hot nitric acid, with distilled water and with ether. They are then thoroughly dried, preferably by repeatedly exhausting them, while hot, with an air pump, and then filling them again with air that has been carefully dried. The next operation consists in filling the thermometer with pure mercury. In order to do this the bulb is heated until the air that it contains is partially expelled and the open end of the stem is then dipped beneath the mercury. As the bulb cools, the air remaining within it contracts and mercury rises through the stem until the bulb has become partially filled; this operation being repeated until the bulb is full. The instrument is next heated to a temperature considerably higher than the highest temperature to which it is to be exposed in use, the mercury that it contains becoming thereby so much expanded that it fills the entire stem and runs over at the top; and while the stem is still filled in this manner it is sealed off at the end by means of a blowpipe. In the higher grades of thermometers, a tiny pear-shaped bulb is left at the top of the stem, partly as a precaution against the destruction of the thermometer in case it is accidentally exposed to too high a temperature in its subsequent service and partly as an aid in the calibration of the stem. When such a pear-shaped bulb is provided, the stem may be sealed off at the end while the internal space is exhausted by means of an air pump, instead of while it is filled with mercury; or the tube may be filled, above the mercury column, with dry nitrogen or some other inert gas. The glass part of the instrument having been completed, it remains to affix the scale to the stem. In high grade thermometers, the scale is engraved upon the stem directly; but in the cheaper forms it is usually engraved or stamped upon a piece of metal or of wood, to which the thermometer is finally secured. Let us consider the high grade instruments first and the cheaper ones afterward. Instruments of the former class are graduated by finding, experimentally, two definite points upon the stem, corresponding to two known temperatures; the two known temperatures which are selected for this purpose being the boiling point and freezing point of water. When these two points are found, the space between them is divided into a certain number of equal parts, which are called degrees. In determining the position of the boiling point upon a thermometer, the instrument is placed in steam that is rising from water that is boiling freely under a barometric pressure equal to that which would be produced by a column of pure, ice-cold mercury, 760 millimeters high, at sea-level in latitude 45°. When the mercury column in the thermometer ceases rising and becomes stationary, the point opposite which it stands is marked upon the stem and is called the «boiling point.» If the barometric pressure under which the experiment is performed is not identically equal to the value assumed above, allowance must be made for that fact by the aid of the experiments of Regnault (or others) upon the variation of the boiling point of water per millimeter of change of barometric pressure. The boiling point having been marked upon the thermometer as here indicated, the instrument is then placed in a mixture of water and finely pulverized ice, as quickly as this can be safely done; and the point to which the mercury sinks is marked and called the «freezing point.» The distance, on the stem, between the boiling and freezing points, is then marked off, by means of a dividing engine, into as many equal spaces as there are degrees between the freezing and boiling points of water and (save for the affixing of numbers to the degree-marks) the thermometer is complete. It may be, of course, that the thermometer is to be divided into half degrees, or into tenths; but the operation is precisely the same, in this case, as it is when the division is to be made to degrees only.

We could evidently divide the space between the boiling point and the freezing point into as many equal «degrees» as we chose; for there is no reason, in the nature of things, why a «degree» could not have any one size, just as well as any other size. It is desirable, however, to have some uniform practice in this respect, and hence the manufacturers of thermometers invariably conform to one or the other of three standard systems. In France, and also for scientific work in nearly every country, it is customary to follow the plan introduced by Professor Celsius of Upsala, which consists in dividing the fundamental interval between the two fixed points into 100 equal parts, the freezing point being called «zero,» or 0°, and the boiling point 100°. This method of graduation is known as the «Centigrade» (or «hundred-degree») system. For general purposes in the United States and in England, it is far commoner to graduate thermometers according to the system introduced by Fahrenheit of Dantzig, about 1714. In this system the interval between the freezing and boiling points is divided into 180 equal spaces, or «degrees»; but the freezing point is here called 32° and the boiling point 212° $(32° + 180° = 212°)$. There has been much discussion as to the reason that Fahrenheit had for dividing the fundamental interval into 180 equal parts; but there can be no doubt but that his zero point was intended to represent the greatest cold that was known in his day, this being obtained by mixing salt and snow. By adopting this lowest temperature as his zero, he probably sought to avoid the use of negative temperatures; but in these days when temperatures several hundred degrees lower than his zero can be produced, the significance of the 32 is lost, and we now adhere to it simply from custom. The third thermometric system that has been used to a considerable extent is that due to Réaumur. In this system the fundamental interval is divided into 80 equal degrees, and the freezing and boiling points are marked 0° and 80°, respectively. This method of graduation is extensively used in Germany upon thermometers intended for household purposes; but for most other purposes in that country it has given way to the Centigrade system.

After a thermometer that is to be used for precise measurement has been made and graduated, it is subjected to certain experimental investigations, for the purpose of ascertaining the errors to which it may be liable. One of the most important of these investigations relates to the «calibration error,» which is due to such irregularities of calibre as the bore of the stem may possess. In order to determine the calibration errors, a thread of mercury of suitable length is detached temporarily from the column in the stem, by shaking the instrument. An expert in this kind of work can usually detach a thread of almost any length that he pleases, whether it be long or short. The instrument is then inclined so that the detached thread may be brought into various positions in the stem; and in certain of these positions its length is observed with great care. The volume of the thread being constant, it is plain that its length will be greater where the calibre of the tube is small than it will be where the calibre is relatively large. The details of the operation of determining the calibration errors of a thermometer are very involved; but the general plan consists in observing the lengths of detached threads of mercury at different points of the stem and then computing from these observed lengths, the relative areas of cross-section of the stem-calibre at various points. It is then possible to calculate a table of calibration corrections, by the aid of which it will be easy to correct any given reading of the instrument, so as to find what reading would have been obtained if the item had been of absolutely uniform calibre throughout.

Prominent among the other sources of error, there are four that merit special attention. (1) In the measurement of a temperature, the bulb of the thermometer is supposed to be fully exposed to that temperature; but since the mercury in the stem must be seen in order to be read, it often happens that the stem of an instrument is necessarily exposed to conditions of temperature that are materially different from those to which the bulb is subjected. Hence there is often a «stem error» to a thermometer, due to the fact that the mercury thread in the stem is colder (or hotter) than that in the bulb, and, therefore, shorter (or longer) than it really ought to be. The magnitude of this stem error will obviously vary with the conditions under which the thermometer is used. It is always uncertain in amount and hence it is customary, in well-executed scientific work, to design the apparatus that is to be used (including the thermometer itself), with special reference to the desirability of keeping the stem error as small as possible. (2) When the barometric pressure upon the bulb of the thermometer varies, the bulb yields elastically to these variations and often to an extent quite sufficient to influence the reading of the instrument by an amount that cannot be neglected. The error due to this cause can be determined and eliminated by means of the «external pressure coefficient,» which is obtained by subjecting the thermometer, at some fixed temperature, to a known change of external pressure and noting the alteration of the reading that this variation of pressure produces. (3) The pressure of the mercury upon the inner surface of the bulb may vary from several causes, one of which is the position of the thermometer itself. If the stem is in a vertical position, the bulb will be subjected to a pressure due to the height of the column of mercury in the stem; and when the thermometer is horizontal, this static pressure will be absent. In small thermometers the error due to this cause is unimportant; but in instruments of high precision, in which the stem may be several feet in length, it must receive due consideration. The constant which is used for correcting for this source of error and which is to be determined by experimenting with the thermometer in different positions but at the same constant temperature is called the «internal pressure coefficient.» (4) It is found that the glass of which a thermometer is composed exhibits certain anomalies in its expansion and contraction, when its temperature is altered. These result in an apparent variation in the position of the «zero point» of the thermometer, which is very troublesome when measurements of the highest precision are to be made. It is on account of this anomalous variation in the position of the zero point that the three kinds of glass mentioned in the earlier part of this article are recommended for the manufacture of the bulb; the variation of the zero having been studied in the case of these species of glass with great care. The phenomena as observed in the case of «verre dur» are thus described by Guillaume: «When a verre dur thermometer is quickly exposed to a temperature of 100° C., after having reposed for a considerable time at the ordinary temperature of the laboratory, its zero point falls with such rapidity that after an exposure of one minute at 100° C. the displacement is practically complete. If the thermometer is then placed in ice-water, its zero ascends, for the first few moments, at the rate of about 0.001° C. per minute; but this rate diminishes rapidly. When a thermometer is maintained at a constant temperature, its zero point rises little by little and the change can be traced plainly for several years. For thermometers of verre dur, the gradual rise at constant temperature amounts to about 0.001° C. per month when the thermometer is two years old; and at the end of four or five years the motion is found to have diminished to about 0.0002° C. per annum.» The ideal way of measuring a temperature, with a thermometer made of one of the three glasses mentioned above, is as follows: The thermometer is exposed to the temperature that is to be measured, and its zero point falls to a certain (presumably unknown) position. After the instrument has been read, it is introduced, as quickly as is consistent with its safety, into a mixture of water and pulverized ice. The mercury sinks at once and soon attains a stable position, which, on account of the slowness of the change of zero with falling temperature, is taken to be the zero corresponding to the higher temperature to which the instrument has been previously exposed. In accordance with this plan, the temperature to be measured is found by subtracting the subsequent reading in ice-water from the reading obtained at the temperature to be determined. The method here outlined, for eliminating the effect of variations in the zero point of a thermometer, is known as the «method of movable zeros,» and is now adopted at practically all of the centres of accurate thermometry except Kew, for temperatures between the freezing and boiling points. It is not yet possible, by any method of procedure, to determine temperatures more than a few degrees below the freezing point, or more than a hundred degrees (Centigrade) above the boiling point, by the aid of a mercury-in-glass thermometer, with a precision comparable with that which is attainable within the fundamental interval that lies between 0° C. and 100° C.

It is to be understood that in the foregoing discussion of the errors of the mercury-in-glass thermometer, we have been treating of the determination of temperatures to such a degree of precision that the final error is not to exceed (say) 0.005° C. No such elaborate care is required, if the only object of the measurement is to determine the temperature to the nearest degree, or half-degree.

Passing now to the consideration of the ordinary thermometers that are used about the household and by amateur meteorological observers, it may be pointed out, first, that in the manufacture of a thermometer that is to be sold at retail for (say) 50 cents, it is not commercially possible to engrave a special scale for each instrument. In making cheap thermometers it is customary to stamp out the scales in large numbers and then to blow the bulb of each instrument to such a size that the scale will be as nearly as practicable adapted to the finished thermometer. This can be done, by an experienced glass-worker, with greater accuracy than might be supposed; but it is evident that no high degree of precision can be attained in this way. The scale and the rest of the thermometer being adapted to each other as nearly as is commercially practicable, the thermometer is adjusted with respect to the scale by exposing it to some known temperature (say 70° F.) in the vicinity of the temperatures at which it is most likely to be used and then securing it in such a position that the point on the stem to which the mercury rises comes opposite the proper mark on the scale. Such a theremometer will give readings that are not greatly in error at temperatures near the one at which it is standardized; but at other temperatures any two such thermometers will necessarily diverge by an amount which depends upon the judgment and skill of the workmen who blew the bulbs and who endeavored to give them capacities adapted to the sizes of the degrees upon their respective graduated scales.

For further information concerning the methods that are used in precise thermometry, consult Guillaume, 'Thermometrie de Précision'; and for the historical aspect of the subject consult H. Carrington Bolton, 'Evolution of the Thermometer.' Consult, also, Preston, 'Theory of Heat.'

Gas Thermometer.—A thermometer in which the temperature is measured by the change of volume, or pressure, of a mass of gas enclosed in a glass envelope. The gases that are most commonly employed for this purpose are air, hydrogen and nitrogen; and thermometers containing these several gases are respectively called «air thermometers,» «hydrogen thermometers» and «nitrogen thermometers.» See THERMOMETRY.

Alcohol Thermometer.—A thermometer in which the temperature is indicated by the expansion of alcohol (instead of mercury); coloring matter of some kind being dissolved in the alcohol, so that the column of fluid in the stem of the instrument may be distinctly visible. Alcohol has a larger coefficient of expansion than mercury, and hence, for the same sizes of bulb and stem, the degrees are longer upon a thermometer containing it. Alcohol can also be used at temperatures that are low enough to destroy an ordinary thermometer, by the freezing of the mercury. No great degree of precision can be attained with the alcohol thermometer, however, partly because the liquid wets the glass and thereby causes the instrument to read too low when the temperature is falling, and partly for other reasons. For the measurement of temperatures approaching the freezing point of mercury (37.8° F. below zero) the International Bureau of Weights and Measures prefers a thermometer filled with toluene to one that is filled with alcohol; the toluene thermometer being apparently capable of yielding much more accurate results. Owing to the fact that alcohol boils at a much lower temperature than water, the alcohol thermometer can hardly be graduated by the method given for the mercury instrument, since exposure to a temperature of 212° F. would cause the alcohol to have a vapor pressure so high that the bulb would be likely to burst. These thermometers are, therefore, graduated, most commonly, by direct comparison with a standard mercury-in-glass instrument. The expansion of alcohol by heat is not strictly proportional to that of mercury and hence if the scale of the mercury thermometer is taken as the standard, the degree marks upon the alcohol thermometer will not be spaced at uniform intervals. These spaces are in fact smaller at low temperatures than at higher ones, as will be seen by examining any good alcohol thermometer that is adapted for observing a considerable range of temperature.

Maximum and Minimum Thermometers are thermometers which automatically record the highest or lowest temperatures to which they have been exposed during a given period. In the Rutherford maximum thermometer the capillary stem of the instrument is placed nearly horizontal and as the mercury rises it pushes before it a tiny index of iron or steel, placed within the tube; and the index, being left at the most extreme position attained by the mercury, indicates the highest temperature to which the instrument has been exposed. In the Rutherford minimum thermometer a similar index is used, but the thermometric column is here composed of alcohol and the index lies within the alcohol. When the temperature falls, the free end of the column of alcohol in the stem adheres to the index and drags it toward the bulb; but when the temperature rises again, the alcohol flows around the little index (which does not fill the capillary tube), and so leaves it in the position to which it had been drawn at the moment when the temperature was lowest. In both forms of thermometer the index is returned to a suitable position for making a new observation by the aid of a small magnet. In the Negretti and Zambra maximum thermometer the capillary tube is partially obstructed near the bulb so that although the mercury flows outward readily enough as the temperature rises, a fall of temperature at any moment causes the mercury thread in the stem to break at the obstruction, so that the maximum temperature to which the thermometer has been exposed can be read directly, in the usual manner. The broken thread can easily be returned to the partially empty bulb by jarring the instrument, or by whirling it sharply in a circle.

Clinical Thermometer.—A form of the Negretti and Zambra maximum thermometer, which is used by physicians for determining the temperature of the human body.

The graduation on these instruments is fine, so that the temperature can be read to the 10th of a degree or so; and the entire interval covered by the graduation rarely extends below 95° F., or above 115° F., the normal temperature of the body being about 98° F. In using the instrument, the bulb is placed under the patient's tongue or in the arm-pit.

Radiation Thermometer.—A form of thermometer designed to indicate the intensity of solar or terrestial radiation. The solar radiation instrument consists of a thermometer with a blackened bulb, the stem being sealed into an exhausted sphere of glass, so that the blackened bulb comes in the centre of the sphere. When sunlight is allowed to fall upon this thermometer and also upon a similar one with a bulb that is silvered and polished, the black bulb absorbs most of the radiant heat, while the polished one reflects most of it. The difference in the readings of the two instruments is assumed to indicate the intensity of the radiant energy falling upon them.

Upsetting Thermometer.—A form of thermometer provided with a constriction in the stem similar to that used with the Negretti and Zambra maximum thermometer, and so designed that when the instrument is inverted the mercury thread breaks at the constriction and runs down into the stem. These instruments are graduated so as to read correctly when they are held upside down. By upsetting a thermometer of this kind by means of clockwork, the temperature that prevails at any particular hour can be recorded.

Deep-Sea Thermometer.—An instrument commonly of the upsetting type, for observing temperature at various depths in the sea. It is enclosed in a very strong case, and is reversed at the depth at which the temperature is desired. At moderate depths the reversal is effected by sending a weight down along the sounding wire; but at greater depths the upsetting mechanism is usually actuated by a small propeller which is arranged so as to begin its rotation when the thermometer starts on its return to the surface of the sea.

Registering Thermometer.—Any thermometer which automatically records its own readings.

Dew-Point Thermometer.—A thermometer adapted to the determination of the temperature at which dew will be deposited from the air. The most accurate form of the instrument is that devised by Regnault. This consists of a pair of thin receptacles of polished silver, shaped somewhat like ordinary chemical test-tubes. A thermometer is placed in each of these, and one of the tubes is then partially filled with ether, or some other volatile liquid. When a current of air is passed through the ether by means of an aspirator, the rapid evaporation cools the silver tube and its contents (including the thermometer); and the observation consists in noting the temperature of the ether, when the polished exterior of the silver tube containing it is first dimmed by the deposition of dew. The second tube of silver, which is not cooled, assists the eye in judging when the dew is first deposited upon the other one; and the thermometer that the uncooled tube contains is used merely to record the temperature of the air at the time of the experiment.

Differential Thermometer.—An instrument for measuring or detecting differences of temperature, without reference to the absolute values of the temperatures that are compared. Sir John Leslie's form, as improved by Rumford, consists of a horizontal tube, turned upward at the two ends, and there provided with a pair of equal bulbs of considerable size. The bulbs are filled with air, and a small quantity of colored liquid is placed in the horizontal tube which joins them; the liquid serving to separate the air masses that the bulbs contain, and also as an index for reading the instrument. So long as the temperatures of the two bulbs remain equal, the pressure of the air will be the same in each, and the liquid index will not move. If one of the bulbs is warmed slightly more than the other one, however, the air that it contains expands and forces the liquid index toward the cooler bulb; the amount of this displacement indicating the difference in the temperatures of the bulbs. This form of differential thermometer is not used to any great extent at the present time, the thermo-pile (see THERMO-ELECTRICITY) and the platinum resistance thermometer (see THERMOMETRY) having almost entirely displaced it.

Wet Bulb Thermometer.—A thermometer whose bulb is covered with thin wet muslin, and which is used for determining the amount of moisture in the air. In practice, the wet bulb thermometer is used in connection with a similar thermometer having a dry bulb, the two being whirled through the air together, or having a current of air directed upon them by a fan, or otherwise. The evaporation of the moisture about the wet bulb causes that instrument to become cooler than the other one; and the difference in the readings of the two thermometers, when taken in connection with the reading of the dry one, enables the observer to determine the degree of saturation of the air at the time the experiment is made. Tables for this purpose are published by the Weather Bureau.

Weight Thermometer.—A thermometer consisting of a bulb provided with a capillary outlet in the place of the usual stem. In using this instrument, the bulb is first weighed while empty, and again when filled with ice-cold mercury. It is next heated to the boiling point of water, and the mercury which escapes from it on account of the expansion is collected and weighed. These data enable the observer to calculate the fraction of the original weight of ice-cold mercury that is lost upon heating the bulb to the boiling point. To determine any other temperature, he fills the bulb, as before, with ice-cold mercury, and then exposes it to the temperature that is to be measured (this temperature being assumed to be higher than the freezing point of water). Collecting the mercury that runs out of the bulb, and expressing its weight as a fraction of the weight of cold mercury that was present at the outset, he has only to compare the fraction so obtained with the fraction obtained in the first experiment, in order to be able to calculate, by a simple proportion, the temperature desired. The weight thermometer is not a convenient instrument to use, but it is simple in theory, and is free from certain of the errors to which ordinary thermometers are liable.

Metallic Thermometer.—An instrument in which temperature is determined by noting the change of form or of length that a metallic strip experiences when it is heated. In Bréguet's instrument, three thin strips composed respectively of platinum, gold and silver are rolled together into the form of a single ribbon, the gold being in the centre. The ribbon is then coiled into a spiral, with the silver on the concave side. When one end of such a spiral is fixed, a rise of temperature causes the spiral to partially unwind, owing to the fact that the coefficient of expansion of silver is greater than that of gold, while the coefficient of gold is also greater than that of platinum. The free end of the spiral is caused to actuate a pointer, by which the temperature is indicated.

Platinum Resistance Thermometer.—An instrument for determining temperature, by noting the variation of the electrical resistance of a wire or strip of platinum. (See THERMOMETRY).

ALLAN D. RISTEEN,
Director of Technical Research, The Travelers Insurance Company, Hartford, Conn.

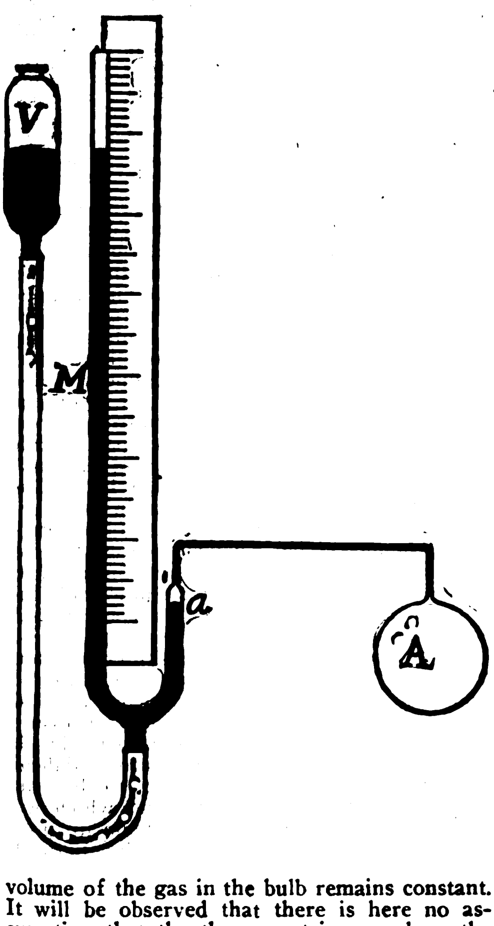
THERMOMETRIC ANALYSIS. See CHEMICAL ANALYSIS.

THERMOMETRY, the art of measuring temperatures. The «measurement» of temperature is quite a different thing from the measurement of a time, or a length, or a mass, and it consists merely in assigning to each temperature that may come up for consideration a definite place upon some sort of a numerical scale. The scale itself may be perfectly arbitrary, so that an interval of temperature upon one part of the scale cannot be said to be «equal,» in any physical sense, to an interval on some other part, even though the two are expressed by the same number of «degrees.» The chief essentials of a practical thermemetric scale are (1) that it shall be perfectly definite, so that when the same temperature is «measured» on several different occasions, the same identical result will be obtained each time, at least to a degree of approximation sufficient for the purposes for which the temperature is being determined; and (2) that it shall be possible for two or more different observers, provided with distinct instruments of measurement, to measure the same temperature, and obtain results that are identical, at least to the same degree of approximation as noted above. So long as these essential conditions are fulfilled, we may make use, for the purpose of establishing a thermometric scale, of any measurable property of matter, which varies in a determinate way with temperature; the «temperature,» in any such case, being defined as proportional to the atttribute that is measured, or to any continuous function of that attribute. We may, therefore, have as many different «scales» of temperature as we please, and any one of these will be just as defensible, and just as «correct,» as any other one, although no two of them will be in perfect agreement. In practice it is found that four particular kinds of thermometric scales are especially useful. These are based, respectively, upon (1) the expansion of some substance that is subjected to an unvarying pressure; (2) the increase in pressure of a gas which is kept rigorously constant in volume; (3) the variation of the electrical resistance of a conductor; and (4) the electromotive force of a thermo-electric couple (see THERMO-ELECTRICITY), one of whose junctions is kept at a constant temperature, while the other is exposed to the temperature that is to be measured. Of these four general methods, the first two have been longest and most commonly employed; and the particular instruments that have been most extensively used for putting them into practice are known respectively as the «mercury-in-glass thermometer» and as the «gas thermometer.» The mercury-in-glass instrument is described under THERMOMETER, and the gas thermometer is described in the present article, below.

The gas thermometer was probably the first form of thermometer to be constructed. The mercury-in-glass instrument followed, and for many years was used almost exclusively for the measurement of temperatures, doubtless on account of its simplicity and the ease with which it can be used. But as the science of thermometry developed, and increasing refinement in temperature determinations was demanded, it was found that the mercury-in-glass thermometer is liable to serious errors on account of the anomalous expansions and contractions of the glass envelope; errors which were of little or no importance when a determination of temperature to the nearest quarter of a degree or so was considered sufficiently accurate, but which were of paramount importance when it was proposed to determine a temperature to the hundredth or thousandth of a degree. The errors due to the cause in question can now be eliminated in large measure by making temperature determinations by the «movable zero» method (see THERMOMETER); but physicists nevertheless prefer to follow the lead of Regnault, who, in his celebrated 'Fourth Memoir' (1847), recommended the employment of the gas thermometer as the standard for the establishment of the temperature scale; and the gas thermometer is still the standard in all work of high precision. The great advantage of the gas thermometer consists in the fact that the coefficients of expansion of gases are many times greater than that of mercury, and the effects of anomalous changes of size in the glass bulb are of correspondingly less importance.

The gas thermometer is made in two general forms, according as it is desired to measure the temperature by the expansion of the gas at some constant pressure, or by the increase in the pressure of the gas at some constant volume. The latter plan being the one that is now by far the commoner in accurate work, we shall describe it first, and at some length.

The constant-volume gas thermometer is shown, in its essential features, in the accompanying illustration. It consists of a bulb, A, of considerable size, which is connected, by means of a capillary tube, with a mercury manometer, M. At a there is a mark upon the tube leading to the gas bulb, and care is taken, whenever an observation of any kind is made, to have the level of the mercury in the short arm of the manometer stand exactly at a, in order that the volume of the thermometric gas may always be rigorously the same. A movable reservoir of mercury, V, is connected with the column M for this purpose, by means of a flexible tube; so that by raising or lowering V the mercury in M may be brought to any desired level. Any gas that we please may be used in the bulb A, but hydrogen, nitrogen and air are the ones most commonly employed. In the filling of the bulb, the most elaborate precautions are taken, not only to have the gas that is used pure, but also, and more particularly, to have it perfectly dry. For this purpose the bulb is first exhausted by the aid of an air-pump, and is heated while in the exhausted condition, and allowed to stand for a time, so that any moisture that may adhere to the walls of the bulb may be driven off and removed. The bulb is then filled with gas that has been carefully dried by calcium chloride or other drying agents, and is then exhausted again and heated; the operations of exhausting and refilling being repeated several times, until there can be no doubt about the dryness and purity of the gas which is finally allowed to remain. Temperature, according to this instrument, is defined as being rigorously proportional to the pressure that prevails in the bulb A, so long as the



volume of the gas in the bulb remains constant. It will be observed that there is here no assumption that the thermometric gas obeys the laws of Boyle and Charles (see THERMODYNAMICS); the relation which has just been assumed being the *definition* of the term «temperature,» according to the constant-volume gas thermometer. If T be the temperature as thus defined, and P is the pressure prevailing within the bulb A, then we have, from the definition of temperature, $T = CP$, where C is a constant for the particular thermometer under consideration. (It is to be observed that P is the *total* pressure to which the gas in A is subjected. It includes not only the pressure that is read from the manometer M, but also that barometric pressure that prevails at the same time in the air of the laboratory; for this barometric pressure acts upon the top of the mercury column, and it is, therefore, to be added to the reading of the manometer M). To deduce the value of the constant C, we may subject the bulb A successively to the steam from boiling water, and to a mixture of ice and water, as described under THERMOMETER. The total pressure upon the gas in the bulb being noted in each case, let us suppose that it is P_0 at the freezing point, and P_{100} at the boiling point. Then the foregoing equation, when applied to these two cases, takes the following forms, respectively: $T_0 = CP_0$, $T_{100} = CP_{100}$; T_0 being the temperature of the freezing point according to the scale of this thermometer, and T_{100} being that of the boiling point. We may define either T_0 or T_{100} however we please, and then find the corresponding value of C; but it is desirable that the scale of the gas thermometer shall be as closely as possible like that of the ordinary mercury-in-glass instrument; and in order to fulfil this condition it is found to be best to subject the gas thermometer scale to the condition that the difference between T_0 and T_{100}, as determined by the gas thermometer, shall be numerically the same as the difference between the freezing and boiling points, on the ordinary mercury-in-glass scale. In other words, it is found to be best to have the average size of the degrees the same on the two instruments. In scientific work the Centigrade scale is used in practically every instance; and if we adopt it here, we shall have the relation $T_{100} - T_0 = 100°$, if the condition just mentioned is to be fulfilled. From this and the preceding equations we easily find that $C(P_{100} - P_0) = 100°$, or $C = 100/(P_{100} - P_0)$; so that when we know the values of P_{100} and P_0 by direct observation, we are prepared to determine C at once, and hence to calculate the gas-temperature, T, corresponding to any given pressure P, by means of the relation $T = CP$. It will be seen that the zero of the gas thermometer scale does not coincide with the freezing point of water, but that it is very much lower. The gas thermometer could not give $T = 0$, for example, *unless* $P = 0$; that is, not unless the temperature was so low as to cause the gaseous pressure to disappear altogether. The zero point from which the indications of the gas thermometer are counted, according to the formula given above, is called the «natural zero» of the instrument; and in order to be able to compare the gas scale with the scale of the ordinary mercury-in-glass thermometer, it becomes necessary to know what the temperature of freezing water is, as read from the gas scale. To determine this, we make use of the relation $T_0 = CP_0$. Substituting in this the value of C as already found, we find that $T_0 = 100P_0/(P_{100} - P_0)$. Now the quantity $(P_{100} - P_0)/P_0$ is known as the «coefficient of expansion at constant volume» for the gas. (The name is somewhat absurd, it is true, because there is no expansion at all, if there is no change of volume; and it would be more accurate to designate this fraction as the "coefficient of increase of pressure" at constant volume). It appears, therefore, that the temperature of melting ice, on the scale of the constant-volume gas thermometer, is numerically equal to 100 times the reciprocal of the coefficient of expansion of the gas at constant volume. Having found T_0, we have only to subtract it from every reading of the gas thermometer, in order to reduce that reading to its corresponding value as reckoned from the freezing point of water. If we call the values of $T - T_0$, as computed for any given gas thermometer, the "reduced readings" of that thermometer, then we find that the reduced readings of the nitrogen, hydrogen, air and carbon dioxide constant-volume thermometers are all nearly identical, and that they are all closely comparable with the readings of the ordinary mercury-in-glass thermometer. If two constant-volume gas thermometers be filled with the same gas in different states of density, then the reduced readings of the two are very nearly equal, but yet not necessarily identical.

The coefficients of expansion at constant volume of certain of the more important thermometric gases are given in Table 1, as deduced from a careful analysis of the data given by Chappuis, Regnault and numerous other experimenters of high standing. The "initial pressure" signifies the pressure on the gas in the thermometric bulb, when the bulb is surrounded by ice and water; this pressure being given as the most convenient way of fixing the density for which the coefficients were determined. Two coefficients are given for air at each initial pressure, because it appears to be

1.— Coefficients of Expansion at Constant Volume.

GAS	Initial pressure = 1,000 mm.		Initial pressure = 760 mm.	
	Coefficient of expansion	T_0	Coefficient of expansion	T_0
Hydrogen	0.0036624	273.04°	0.0036624	273.04°
Nitrogen	0.0036745	272.15	0.0036716	272.36
Carbon dioxide	0.0037258	268.40	0.0037106	269.50
Air	0.0036746	272.14	0.0036716	272.36
Air	0.0036720	272.33	0.0036697	272.50

impossible to decide, from the observations thus far made, which one of these values is most likely to be correct, the available measures falling into two general groups, one of which favors one of the foregoing values, while the second favors the other one. In Table 1 the values of T_0 are also given, for convenience of reference.

The International Committee of Weights and Measures, in consideration of the differences that exist even between the reduced readings of constant-volume gas thermometers, adopted the following standard scale for the measurement of temperature, calling it their "normal thermometric scale." The scale adopted is the Centigrade scale of the constant-volume hydrogen thermometer, in which the hydrogen has a density such that its pressure, at the freezing point of water, is equal to that due to a column of ice-cold mercury, one metre (1,000 mm.) high. The temperatures are understood to be "reduced," as described above, so that the thermometer reads 0° at the freezing point and 100° at the boiling point. The ideal scale would of course be the absolute thermodynamic scale (see Thermodynamics); but the corrections that are required in order to reduce gas thermometer readings to this scale are still too uncertain to be definitely adopted in precise thermometry.

2.— Comparative Readings of Constant-volume Gas Thermometers and the Mercury-verre Dur Scale ("Reduced" Temperatures).

Hydrogen	Nitrogen (or air)	Carbon dioxide	Mercury
− 10° C.	− 10.007°	− 10.032°	−10.077°
0	0.000	0.000	0.000
+ 10	+ 10.006	+ 10.025	+10.051
+ 20	+ 20.010	+ 20.043	+20.084
+ 30	+ 30.011	+ 30.054	+30.102
+ 40	+ 40.011	+ 40.059	+40.112
+ 50	+ 50.009	+ 50.059	+50.104
+ 60	+ 60.005	+ 60.053	+60.084
+ 70	+ 70.001	+ 70.044	....
+ 80	+ 79.998	+ 80.031	....
+ 90	+ 79.997	+ 90.016	....
+100	+100.000	+100.000	100.000

In Table 2 comparative readings are given, of the mercury-in-glass ("verre dur"; see Thermometer) scale, and the scales of the constant-volume hydrogen, nitrogen and carbon dioxide thermometers, in which the "initial pressures" are 1,000 millimetres of mercury. The significance of the table will be made plain by the following example: If all of these thermometers were exposed to a temperature at which the "reduced" reading of the hydrogen instrument was 30° C., then the nitrogen thermometer would read 30.011°, the carbon dioxide thermometer would read 30.054° and mercury-in-glass thermometer would read 30.102°. The readings given in the second column were obtained from experiments made upon the nitrogen thermometer; but Chappuis states that the reduced readings of the air thermometer and of the nitrogen thermometer are practically indistinguishable; and hence this column will serve for each of them.

In the constant-pressure gas thermometer, temperature is defined as proportional to the volume of a fixed mass of gas which is allowed to expand in such a manner that its pressure remains constant. Regnault experimented with thermometers of this class, and considered them to be distinctly inferior in accuracy to those in which the volume is constant, and which we have already described. This judgment pronounced by Regnault has met with the approval of nearly every subsequent authority upon experimental physics, and hence the constant-pressure gas thermometer has not been at all extensively used in practical work. Professor H. L. Callendar, in fact, is almost the only prominent advocate of the constant-pressure instrument at the present time. He claims that the constant-pressure gas thermometer is capable of yielding results even superior to those of the constant-volume thermometer; and he has devised a very ingenious form of the constant-pressure instrument, which certainly appears to overcome most of the objections that have been urged against it in the past. (Consult his paper entitled 'On a Practical Thermometric Standard,' in the *Philosophical Magazine,* for 1899, Vol. 48, page 519. Consult also, 'Proceedings of the Royal Society,' Vol: 50, 1892, page 247, and Preston, 'Theory of Heat'). To facilitate computations connected with the constant-pressure gas thermometer, we present, in Table 3, the coefficients of expansion of the principal thermometric gases at the constant pressure of 1,000 millimeters of mercury and also at 760 millimeters. These are obtained by a careful comparison of the best determinations that have yet been made.

3.— Coefficients of Expansion of Gases at Constant Pressure.

Gas	Pressure = 1000 mm.		Pressure = 760 mm.	
	Coefficient of expansion	T_0	Coefficient of expansion	T_0
Hydrogen.......	0.0036600	273.22°	0.0036606	273.18°
Nitrogen.......	0.0036731	272.25	0.0036707	272.43
Carbon dioxide..	0.0037422	267.22	0.0037247	268.48
Air...........	0.0036734	272.23	0.0036706	272.44

The coefficient of expansion of carbon dioxid at a constant pressure of 760 millimeters of mercury must be considered as still somewhat uncertain, though the value given in the table appears to be the best now attainable. The «natural zero» of the constant-pressure thermometer lies in about the same general region as the natural zero of the constant-volume instrument. The temperature of melting ice, as referred to the «natural zero» of the scales of the several constant-pressure gas thermometers, is given in Table 3, in the columns headed «T_0.» No extensive and accurate comparisons have yet been made between the constant-pressure and constant-volume thermometers, either for the same gas or for different ones.

In the platinum-resistance thermometer, temperature is defined as proportional to the electrical resistance of a coil of pure, annealed platinum wire. The «thermometer» itself consists of a coil of the wire, wound upon a sheet or strip of mica, and placed in one of the arms of a Wheatstone's bridge, so that its resistance may be accurately determined. It is usual to denote a temperature as defined by the platinum-resistance thermometer by the symbol «pt» («platinum temperature»). We have, therefore, $pt = CR$, where R is the observed resistance of the coil at the temperature denoted by pt and C is a constant whose value is to be determined. If R_0 and pt_0 and R_{100} and pt_{100} are the respective resistances and platinum-resistance temperatures at the freezing and boiling points of water, then we have, precisely as in the case of the constant-volume gas thermometer, $pt = 100\ R/(R_{100} - R_0)$, as the platinum-resistance temperature, as reckoned from the «natural zero» of the platinum-resistance thermometer. The «reduced platinum temperature,» obtained by subtracting pt_0 from the temperature pt as here computed, is the one that is commonly used, however; and Callendar and Harker and Chappuis have shown that the reduced platinum-temperature can be expressed in term of the reduced gas thermometer scale by means of a simple equation of the form:

$$pt = T + A.\frac{T}{100}\left\{\frac{T}{100} - 1\right\}$$

A being a constant whose value is to be determined experimentally. Callendar and Griffiths, for the purpose of determining A, recommend that the resistance of the platinum coil of the thermometer be observed at the temperature of boiling sulphur; the «reduced temperature» of this boiling point being, according to their experiments with the constant-pressure air thermometer, 444.53° C. (Eumorfopoulos states that the boiling point of sulphur on this scale is between 443.58° and 443.62° C. See 'Proceedings of the Royal Society,' 1908 A, 81, p. 339. Compare, also, Callendar and Moss, in the same publication, 1909 A, 83, p. 106). The platinum-resistance thermometer gives great promise of being a highly valuable instrument in the future. Indeed, it is so already; but it does not yet appear to be capable of determining the absolute values of temperatures closer than to 0.01° C. It may be used as a differential thermometer, however, so as to give results of a far higher order of accuracy. For this purpose two similar coils or strips of platinum are used, these being placed in two of the arms of a Wheatstone's bridge, so that the smallest departure from equality in their resistances can be observed. (See Resistance, Electrical). Langley's bolometer is an instrument of this sort. It is used to explore the solar spectrum, and consists of two strips of platinum foil, which are placed across the spectrum to be examined, with their edges toward the source of the light. The two strips are placed in the two arms of a sensitive Wheatstone's bridge, and so long as both the strips are exposed to radiation of the same intensity, the balance of the bridge is preserved. When one of the strips coincides with a Fraunhofer line, however, while the other is still exposed to the full radiative power of the source of light, the balance is destroyed, and the existence of the line is thereby demonstrated, even though the line be in the infra-red, where it is not visible to the eye.

Thermo-electric couples have been used to a considerable extent for the measurement of temperature, and Regnault experimented with them somewhat, but showed that they are distinctly inferior in accuracy to the other known methods of determining temperature. At exceedingly low temperatures, however, they are often of great value. Wroblewski, for example, made use of thermo-couples quite extensively for temperature measurements in his researches on the critical points of the gases which are liquefiable only at extremely low temperatures. The platinum resistance thermometer is more generally favored, however, for this purpose; though it cannot be used for temperatures too close to the absolute zero on account of the anomalous and sudden changes of resistance that occur in that region. (See Resistance, Electrical). At these extremely low temperatures the helium thermometer is still useful, however.

Consult Guillaume, 'Thermometrie de Précision,' and Preston, 'Theory of Heat.' See, also, the numerous scientific papers of Kamerlingh-Onnes relating to low-temperature research.

ALLAN D. RISTEEN,
Director Technical Research, The Travelers Insurance Company, Hartford, Conn.

THERMOPHONE, a resistance thermometer (see THERMOMETRY), in which the galvanometer that is most commonly employed is replaced by a telephone. Two coils of platinum wire, which are exposed to the respective temperatures that are to be compared, are introduced into two of the arms of a Wheatstone's bridge whose remaining arms contain known resistances. The telephone is placed in the cross-arm of the bridge. An alternating or pulsating current of low frequency is used in making the observation, and when the bridge is in balance, this fact is indicated by the silence of the telephone. See Warren and Whipple, 'The Thermophone,' in *The Technology Quarterly,* Vol. VIII, page 125.

THERMOPOLIS, Wyo., town and county-seat of Hot Springs County, on the Chicago, Burlington and Quincy Railroad, and on the west bank of the Bighorn River. It is noted for the large hot springs which issue along the river bank at this place. These springs are considered curative for rheumatism and similar ailments. They are protected as a State reservation. Pop. 1,500.

THERMOPYLÆ (Gk. θερμοπύλαι hot gates), in classical geography, a pass on the southeastern frontier of Æniania, Greece, leading from Thessaly into Locris, and on the route of the only good road from Thessaly to central Greece. It was situated between the range of Mount Œta and an inaccessible morass which bordered the Maliac Gulf; and in breadth it was a narrow tract of perhaps some 50 feet. Its name was derived from the presence of thermal springs. As the only means by which a hostile army might penetrate from northern into southern Greece, it held a peculiar strategic value in Grecian history. It is celebrated as the scene of the defense by Leonidas (q.v.) and the 300 Spartans against the vast host of Xerxes (q.v.) in August 480 B.C. The account of this battle given by Herodotus has been generally followed. Xerxes, ridiculing the numbers of the Hellenic defenders (5,200, not counting the Locrians, whose numbers are not known), sent against them the Medes and Cissians with instructions to take them prisoners and bring them before him. When, after a day's fighting, these were unsuccessful, the picked 10,000, called the «Immortals,» were sent forward; but, handicapped by the shortness of their spears, they were no match for the Hellenes, of whom few fell, while the Persian loss was on both days excessive. Xerxes was now in great perplexity, when Ephialtes, a Malian, came «to tell him of the pathway which led across the mountain to Thermopylæ.» This path ascended the gorge of the river Asopus, and the hill Anopæ; then passed over the crest of Œta and to the rear of Thermopylæ. The Persians arrived in the rear of Thermopylæ soon after mid-day of the third day. Tidings of their coming had already been brought to the Greeks by scouts and Persian deserters. Most of the Greeks withdrew, but the Spartans and the Thespians (700) remained, and the Thebans (400) were compelled to stay. Of the Spartans and Thespians, all fell; and of the Thebans, few escaped. To the complaint that the Persian arrows darkened the sky the Spartan Dieneces is said to have answered, «Good; then we shall fight in the shade.»

Through deposits from the Spercheius and other streams, great alterations have taken place at Thermopylæ, so that it is not now a pass but a swampy plain. Consult Schliemann, 'Untersuchungen der Thermopylen' (1883) and various standard histories of Greece. See also GREECE, ANCIENT — *History.*

THERMOPYLÆ OF AMERICA, a title applied to Fort Alamo, Texas. See ALAMO, THE.

THERMOSCOPE (Greek, «to show heat»), any instrument for indicating temperature. The term is commonly applied, however, to such instruments as indicate one temperature only, or a very limited number of temperatures; or to those which are used for indicating changes or difference of temperature, without giving the magnitude of these changes or differences. The forms that have been given to instruments of this kind are so manifold as to be almost past numeration. As a single illustration, the instrument may be cited, whose indications depend upon the melting points of alloys. An instrument or device of this sort contains buttons or wires of a number of alloys, whose several melting points are known; and in the observation of temperature by this method, the instrument is exposed to the temperature under examination, and a note is made of which of the alloys melt, and of which remain unmelted. If T_1 is the melting point of the least fusible of the alloys that have melted, and T_2 is the melting point of the most fusible of the alloys that have not melted, we can then assert that the temperature under consideration is higher than T_1, but lower than T_2. For many purposes in the arts, it is quite sufficient to know, in this manner, that a temperature is between certain limits. A thermoscope which can only indicate certain limits between which a temperature lies is called a «discontinuous thermoscope.» Continuous thermoscopes, which are capable of affording an actual measurement of any temperature within their range, are now commonly called «thermometers,» whether they resemble the ordinary mercury-in-glass thermometer or not. A thermoscope in which temperature is inferred by noting the electrical resistance of a coil of platinum wire, for example, is called a «platinum resistance thermometer.» See PYROMETER; THERMOMETER; and THERMOMETRY.

THERMOSTAT, a device in which the variation of heat is utilized to expand and contract a long strip of metal, so that its motion can be utilized to regulate a damper or to maintain approximately uniform steam pressure.

THERMOTAXIS, the regulation of the temperature of the body. The principal sources of animal heat are muscular exercise and the combustion of food, involving absorption of oxygen and liberation of carbon dioxide. Body temperature remains about normal under many trying circumstances through the balance maintained by the nervous system between its production and its dissipation. The chief avenues of dissipation are radiation from the surface of the body, the expired air and the excreta. Febrile action or fever is believed to be due to an overproduction of heat, to an underelimination or to both. The overproduction is believed to result from an increased combustion especially of albuminous substances of the body, with an increased discharge of carbon dioxide and the nitrogeneous wastes, urea, creatine and creatinine. When fever prevails the action of the heart is accelerated, the secretions of glands are impaired and the intricate process of metabolism is deranged. Heat-regulation, effected by reciprocal changes in heat-production and heat-dissipation and depending essentially upon the influence of cutaneous impulses and the temperature of the blood, is governed, it is generally believed, by two nerve-centres, one controlling heat-production, the other heat-dissipation.

THERMOTROPISM, a tendency toward warmth, exhibited in the reactions of animals. An example is found in the care with which ants move their eggs and larvæ from place to place in order to secure a proper and equable temperature for their welfare. Compare HELIOTROPISM, with which tendency this is somewhat confused.

THERMORPHA, or **ANOMODONTIA,** an order of extinct (Triassic and Perman) reptiles. «The dominant group among the earliest reptiles in each quarter of the globe where they have as yet been discovered,» say Woodward, «is directly intermediate in skeletal characters between the highest labyrinthodonts (*Mastododonsaurus* and its allies) and the lower mammals (*Monotremata*). Its members first received the name *Anomodontia* in allusion to the varied modifications of the dentition, so unusual among reptiles. They were afterward named *Theromorphia* or *Theromora* . . . in allusion to the many obvious resemblances in their skeleton to that of monotreme mammals.» These similarities are chiefly of the dentition, zygomatic arch, pelvis, cruro-tarsal joint, scapula and occasional doubling of the occipital condyle. The general shape of the skull is often closely mammalian, but its details show its unquestionable reptilian features. Three suborders are recognized — *Pareiosauria, Theriodontia* and *Anomodontia.*

The theromorphs were all land-reptiles with short, stout limbs and powerful jaws. Some were massive and of great size, like great alligators with turtle-like or even dog-like heads; others small and probably as agile as a weasel. They were the predatory beasts of their age, and were adapted in powers and characteristics to the pursuit of a large variety of animal prey. The most unreptile-like were those of the suborder *Theriodontia.*

It is a natural suggestion that the race of mammals, undoubtedly of reptilian origin, must have descended from this group, whose bones (numerous in the Triassic rocks of the western United States) show so many mammalian features; but thus far no direct connection can be shown. The dinosaurs, however, seem certainly to have descended from this stock. Consult Woodward, ‹Vertebrate Palæontology› (London 1898); Gadow, ‹Amphibia and Reptiles› (New York 1901), wherein many further references to details will be found.

THEROPODA, a sub-order of dinosaurs (q.v.).

THERSITES, thėr-sī'tēz, according to Homer, the ugliest man in the whole Grecian army that beleagured Troy. He was a malicious and slanderous brawler whom Ulysses publicly beat and brought to tears for his insulting attack on Aganon. He was eventually slain by Achilles for piercing with his spear the eye of the dead queen of the Amazons, Penthesilea, whom he had also spoken of with contumely.

THERY, Edmund, French writer on economics: b. Ragnac, France, 1854. He is a commander of the Legion of Honor, member of numerous societies interested in his line of work and has represented his government in various economic missions to several countries. His writings include ‹Europe et Etats-Unis d'Amérique› (1899); ‹La France economique et financière pendant le dernier quat de siècle› (1900); ‹La Banque de France de 1897 a 1909› (1910); ‹L'Europe économique› (1911); ‹Le regime actuel des chemins de fer en Russie› (1913), etc.

THESEUM, thē-sē'ŭm, or **THESEION,** thē-sē'ŏn, a temple in ancient Athens dedicated to the commemoration of Theseus and his exploits. It stood on an elevated site north of the Areopagus (q.v.) and in early Christian times was used as the church of Saint George of Cappadocia. Within its precincts Cimon is said to have deposited the bones of the hero which he had brought from the island of Scyros, but archæologists do not support this claim. The temple was begun 465 B.C. Many consider it to have been originally dedicated to Heracles or Hephæstus, but there is no reason to doubt that it is actually a Theseum. It was constructed of Pentelic marble in the purest Doric style and is technically to be described as an amphiprostyle, hexastyle peripteral temple, with pronaos, and opisthodomos or epinaos. The façade and rear pediment have each six columns; the sides 13 each; their height being about 30 feet. A fragment of the portico and the roof of the stella are still standing. There are also some noteworthy remains of the statuary with which the building was adorned by sculptors of the school of Phidias. On the metope are set forth the exploits of Theseus and Heracles and the frieze of the cella is also in part standing. The dimensions of the building are roughly to be estimated at 104 x 45½ feet. Consult Stuart and Revett ‹Antiquities of Athens› (London 1762–1816); Leake, ‹Topography of Athens› (London 1841); Dyer, ‹Ancient Athens, Its History, Topography and Remains› (London 1873).

THESEUS, thē'sūs or thē'sē-ŭs, in Greek legend, a king of Athens and national hero of Attica, son of Ægeus by Æthra, the daughter of Pittheus of Trœzen, in Peloponnesus. He was educated at Trœzen, at the house of Pittheus, and passed for the son of Poseidon (Neptune). When he came to years of maturity he was sent by his mother to his father, and a sword and sandals were given him by which he might make himself known to Ægeus (q.v.) in a private manner. On arriving at Athens he narrowly escaped being poisoned by Medea, the sorceress, but his father recognized the sword, and received Theseus as his successor on the throne. He next caught alive the wild Marathonian bull; but a much more important service was the slaying of the Minotaur and the freeing of Athens from the tribute of seven youths and seven maidens annually sent to Crete to be devoured by that monster. (See MINOTAUR). Fearing his son had perished while in Crete Ægeus destroyed himself; hence Theseus on his return succeeded his father as ruler of Athens. The Athenians were governed with mildness, and Theseus made new regulations and enacted new laws. The number of the inhabitants of Athens was increased: a court was instituted, which had the care of all civil affairs; and Theseus made the government democratic, while he reserved for himself only the command of the armies. To him also the Athenians ascribed the union of the towns of Attica into a single state, with Athens at the head, and the division of the people into the three classes of Eupatridæ, Geomori and Demiurgi (nobles, husbandmen and mechanics). Perhaps the most celebrated of the events in the career of Theseus after the slaying of the Minotaur was his war with the Amazons. He is said to have invaded their territory and carried off their queen, Antiope (according to another account, that with which the readers of Chaucer and Shakespeare are familiar, Hippolyta). The Amazons in their turn invaded Attica, and a battle was fought in the city of Athens itself. Theseus was victorious, and the Amazons driven out of Attica. He was absent from Athens on various expeditions, and when he returned the Athenians had forgotten his services. He retired to the court of Lycomedes, king of Scyros, who threw him down a deep precipice. In 469 B.C. his bones, as supposed, were found by Cimon in Scyros, and brought to Athens, where they received a magnificent burial. Statues and a temple (the Theseum, q.v.) were raised; and festivals and games were publicly instituted to commemorate his actions. A portion of the temple still remains standing. What shreds of history, if any, there may be in the accounts of Theseus cannot be ascertained. Consult Harrison, J. E., ‹Mythology and Monuments of Ancient Athens› (London 1890); Lübker, F., ‹Reallexikon des Klassischen Altertums› (Leipzig 1914); Schultz, A., ‹De Theseo› (Breslau 1874).

THESMOPHORIA, a pagan festival of ancient Greece. It was celebrated only by women, in honor of Demeter Thesmophoros («the lawgiver») as foundress of agriculture, and thereby of orderly social life and the marriage. At Athens the festival extended to three days, beginning with 24 October. On the first day there was a procession to the temple of Demeter at Halimos, southeast of the city; on the second a fast; and on the third day, called Kalligeneia («the bearer of a fair offspring»), general and often licentious indulgence.

THESMOTHETE, thĕs'mō-thēt (from a Greek word meaning lawgiver), one of the six inferior archons at Athens who presided at the election of the lower magistrates, received criminal informations, decided civil causes, took the votes at elections and performed other duties.

THESPESIUS, also called Claosaurus, a dinosaur whose fossil remains found in the upper Cretaceous strata in Wyoming, Montana and Colorado show it to have resembled the Iguanodon. It was upwards of 30 feet long and stood from 10 to 25 feet high. Like others of its species it was herbivorous and balanced its long forward body by its heavy tail. Complete sketches of the animal are found in the principal museums. (See DINOSAUR). Consult Marsh, O. C., ‹The reconstruction of the Cretaceous Dinosaur› (in *Transactions* of the Connecticut Academy of Sciences, Vol. XI, New Haven 1902).

THESPIS, Greek author. He was a native of Icaria, a deme of Attica, lived in the time of Solon, in the 6th century B.C., and is considered the inventor of tragedy, as he added to the dithyrambic choruses of the feats of Bacchus an actor, who, when the chorus was silent, generally recited a mythical story; and probably carried on dialogues with the leader of the chorus, appearing successively in different characters in a piece. This was a decided step toward the drama.

THESSALONIANS, Epistles to the. Authorship.— While Paul's authorship of the First Epistle to the Thessalonians has occasionally been questioned, the consensus of critical opinion is at the present time so nearly unanimous in favor of its genuineness that it seems needless to argue the question at all. The external evidence is strongly favorable; the style and vocabulary are admittedly Pauline; the doctrinal content, while not very full, is in harmony with Paul's teachings elsewhere; above all, in its whole tone and temper it is unmistakably and inimitably an outpouring of the very heart and soul of the great Apostle. As concerns the Second Epistle the case stands somewhat differently. Though the external evidence is even stronger than for the First Epistle, yet its Pauline authorship has been far more disputed. The difficulties which have been raised grow mainly out of its relation to the First Epistle, and practically reduce to three: (1) the resemblance in portions of the two letters, considered by some to be too close to permit us to think of the second as an independent composition; in answer to which it is said that this likeness covers no more than a third of the letter, and may easily be explained in any of many ways, as, for instance, that just before writing Paul might have glanced at a copy of his first letter; (2) the difference in tone and temper of the two letters, Paul seeming in the second more formal and less cordial and affectionate, a fact for which several explanations have been offered, as that if the first letter had failed helpfully to affect some of the Thessalonians, he might naturally speak in a more formal and distant way in his second letter, or, as Harnack has suggested, this letter may have been intended solely for the Jewish section of the church, while the other was for the main body of the church, which was Gentile in origin, and more loyal to Paul; and (3) the difference in the eschatological teaching, which, however, does not amount to a contradiction, but is to be regarded partly as a correction of a misunderstanding of the teaching in the first letter, which misunderstanding seems in spite of the correction still to continue in some circles, and partly is an addition of certain elements in Paul's doctrine of the Last Things which had not come out earlier, resulting in an apparent change of emphasis, but not in a real inconsistency. Certainly the difficulties in the way of explaining the letter as a forgery have been found greater than of accepting it as genuine, and consequently the later criticism seems decisively to favor the Pauline authorship of both Epistles.

Date and Place.— From the First Epistle itself in comparison with Acts it is easy to ascertain the date and place of composition. On his second great missionary journey, the second European city in which Paul worked was Thessalonica, the modern Saloniki. Here he established a church at once, but his very success caused him to be driven from the city after a stay possibly of only three weeks, almost certainly of only about as many months. From there Paul went to Greece, making a short stay at Athens and establishing himself for a year and a half at Corinth. It is plain that Timothy, who was sent back from Athens to visit, comfort and confirm the Thessalonian Church, rejoined Paul at Corinth with his report, and the first letter must have been written almost at once. According to some the second letter followed the first even without waiting for an answer and in any case the interval cannot have been long, a few weeks at most. The most common dating is in the spring of 51, but chronologists vary two or three years either way so far as the years to be assigned to the various events of Paul's work are concerned. These Epistles are accordingly among the very earliest New Testament books, only James and Galatians being considered by any to be earlier.

Conditions of Composition.— It is plain from 1 Thessalonians as well as from Acts that the reception of Paul and of his teaching at Thessalonica was peculiarly prompt and cordial. In a very short time a church was established, consisting partly of Jews, but mainly of proselytes and Gentiles, including some of the principal men and women of the city. Paul turned back to Thessalonica as a place where his work had been a peculiar delight, and the mutual affection of the Apostle and his converts must have been unusual. But his stay at the longest had been brief, and in spite of his plans and endeavors he had found it impossible to return, while at the same time he had reason to fear that misrepresentations were being circulated touching both his failure to revisit them and his purposes in his missionary work and his relations to his converts. From the report of his messenger Timothy, and possibly from a letter to Paul from the church, quotations from which some have thought they found embedded in this letter, it appeared that on the one hand a certain fanaticism showing itself in immorality and on the other hand a certain doctrinal and spiritual uncertainty had grown up in the Church. It was to remedy those conditions that Paul wrote his first letter. The second is a natural pendent to the first. It is usually held that Paul's letter mainly accomplished its purposes, but that either by the return of the messenger who carried it or by written response from the Thessalonians themselves, Paul learned that some disorders continued and that his teaching about the Last Things needed supplementing to correct misunderstandings, and thus arose the Second Epistle.

Contents.— These letters are peculiar in that two of Paul's fellow-workers, Silas and Timothy, are associated with him in the address (i, 1), though it is plain that in composition and in thought as well as in personal relations it is definitely his own letter. In 1 Thess., he first gives an explanation of his failure to return to them, adding an assurance of his strong affection for them and an assurance of his confidence in their affection for him and their continuing faith in Christ, all so put as to answer any misrepresentations of him and his work which might be current (i, 2–iii, 13). Then come various moral injunctions, first, to chastity, and then to brotherly love, with which is associated the duty of diligent labor (iv, 1–12). There follows the correction of the painful misunderstanding of some of the Christians as to their friends who had lately died, by the assurance that through their resurrection they would be at no disadvantage when Christ should return, and encouragement for all in reference to the same return (iv, 13–v, 11), and, finally, warnings against various disorders, couched in brief injunctions, and a few salutations (12–28). In the second letter, after a brief greeting (i, 1, 2), Paul gives utterance to a remarkable expression of thanksgiving and prayer (i, 3–12); then corrects the misunderstanding of what he had said in his first letter, assuring them that before the «Day of the Lord» there was much history to be made, including a great apostacy (ii, 1–12); a brief encouragement to fainthearted brethren follows (ii, 13–iii, 5), and warnings to the idle and dissolute (iii, 6–15), the Epistle ending with a word of explanation of how the Apostle added to his dictated letters a certificate in his own handwriting and the benediction with which he commonly closed his letters (iii, 16–18).

Bibliography.— Frame, J. E., ‹Commentary on the Epistle of Saint Paul to the Thessalonians› (International Critical Commentary, 1912); Lake, K., ‹The Earlier Epistle of Saint Paul› (1911); Milligan, George, ‹Saint Paul's Epistle to the Thessalonians› (1908); Moffatt, James, ‹First and Second Epistles to the Thessalonians› (Expositor's Greek Testament, 1910).

DAVID FOSTER ESTES,
Professor of New Testament Interpretation, Colgate University.

THESSALONICA. See SALONICA.

THESSALY, thĕs'ạ-lĭ, or **THESSALIA,** the northeastern division of ancient Greece proper, bounded on the north by the Cambunian Mountains, separating it from Macedonia; on the west by the chains of Pindus and Tymphrestus, separating it from Epirus; on the south by Mount Œta, separating it from Ætolia, Doris and Locris; and on the east by the Ægean Sea. The rich plain enclosed between these mountains belongs almost entirely to one river basin, that of the Peneios (Salambria), which traverses it from west to east, and finds an outlet into the Thermaic Gulf through the vale of Tempe. It was especially famed for its fine breed of horses and its skilful horse-men. The name of Thessaly was derived from the Thessali, a Greek people who are said to have come into this land from the west, and who became the governing class in the country. Thessaly was broken up into separate states loosely united under a tagus, and long exerted no important influence on the affairs of Greece generally; but it rose for a brief period to a position of greater consequence when (about 375 B.C.) Jason of Pheræ, having been elected tagus, brought the whole of Thessaly completely under his power, and began to threaten the rest of Greece, but the confederacy was again weakened after his assassination in 370 B.C. Thessaly afterward became dependent on Macedonia, and finally was incorporated with the Roman Empire. In 1393, after the fall of the Byzantine Empire, Thessaly came, with the rest of the imperial dominions, into the hands of the Turks, and till recently formed a part of the Ottoman Empire. The greater portion of it was in 1881 incorporated in the kingdom of Greece. The Greco-Turkish War of 1897 was fought principally within the borders of Thessaly. Consult Baedeker, K., 'Greece' (4th English ed., Leipzig 1909); Kent, R. G., 'A History of Thessaly from the Earliest Historical Times to the Accession of Philip V of Macedon' (Lancaster, Pa., 1904); Leake, W. M., 'Travels in Northern Greece' (4 vols., London 1835); Philippson, A., 'Thessalien und Epirus' (Berlin 1897); Wace and Thompson, 'Prehistoric Thessaly' (Cambridge 1912).

THETFORD MINES, Canada, town in Megantic County, on the Quebec Central Railway, about 76 miles south of the city of Quebec. It is chiefly known for the deposits of asbestos in the neighborhood. There are numerous small industries. Pop. about 7,500.

THETIS, thē'tis, in Greek mythology, a daughter of Nereus and Doris, therefore one of the Nereids. Her nuptials with Peleus were celebrated on Mount Pelion, and were honored by the presence of all the gods except Eris or Discord, who was not invited, and who, to avenge the slight, threw in among the company the apple of discord. By Peleus she became the mother of Achilles (q.v.).

THEURGY, from the Greek *theourgia*, meaning divine work, and used among the ancients to signify supernatural agency in individual human affairs, or in the government of the world. Hence the act or art of invoking deities or spirits, or by their intervention conjuring up visions, interpreting dreams, receiving or explaining oracles, etc.; the power of obtaining from the gods, by means of certain observances, words, symbols or the like, a knowledge of the secrets which surpass the power of reason, to lay open the future, etc. The word also means that species of magic which more modern professors of the art allege to produce its effects by supernatural agency, as contradistinguished from natural magic. Also a system of supernatural knowledge or power believed by the Egyptian Platonists to have been divinely communicated to a hierarchy, and by them handed down from generation to generation.

THEURIET, Claude Andre, French poet and novelist: b. Marly-le-Roi, 8 Oct. 1833; d. 23 April 1907. He studied law in Paris, received his licentiate in 1857 and in that year entered the department of the Ministry of Finance. Soon, however, he turned his attention to literature. In 1896 he was elected a member of the French Academy, having received the *prix Vitet* in 1890. His poems include 'Le chemin des bois' (1867); 'Le Bleu et le noir' (1873); 'Nos oiseaux' (1886); and 'La ronde des saisons et des mois' (1891). He also published 'Jules Bastien-Lepage, l'homme et l'artiste' (1885), but is best known by his novels, among which are 'Nouvelles intrines' (1870); 'Mlle. Guignon' (1874); 'Channe dangereux' (1891); 'La Chanoinesse' (1893), etc. He was the author of some 60 works of fiction. He also wrote several dramas including 'Jean-Marie' (1871); 'Le maison des deux Barbeaux' (1885), and 'Jour d'été (1901).

THIAN-SHAN (tē-än'shän') **MOUNTAINS,** central Asia. See TYAN-SHAN.

THIAZOL DYESTUFFS. See COAL-TAR COLORS.

THIBAULT, Jacques Anatole France, critic and novelist: b. Paris, 16 April 1844. He is known wherever French is read and the Latin genius appreciated as ANATOLE FRANCE, and was called by Lemaître, one of the shrewdest of his contemporaries, «the ultimate flowering of the Latin genius.» Son of a Parisian bookseller, another «France» and a veteran of the body-guard of Charles X, Anatole grew up in the bookish atmosphere which he has conveyed marvelously into several of his stories as he has also his father's character. A Parisian of the Parisians, he was named officer of the Legion of Honor in 1895 and received into the Academy in 1896. For the rest the story of his life is in his writing. Besides early verses his well-nigh 50 volumes embrace charming books of autobiographic «truth and fiction» such as 'Le livre de mon ami' (1895), 'Pierre Nozaire' (1900) and 'Les désirs de Jean Sévier' (1912); books of philosophic criticism, themselves, as he openly professes, evidencing his own way of thinking in noting the ways of others, chief among them articles collected from *Le Temps* in five volumes of 'La vie litteraire' (1888–93) and 'Le génie latin' (1913); dramatic experiments, among which 'Thaïs' is best known; an extended controversial biography. 'La vie de Jeanne d'Arc' (1908); expressions of fervid patriotism in stress of war, such as 'Sur la voie glorieuse' (1915), and, finally and chiefly, a long series of books which in the guise of fiction express all the manifold phases of his political observations, his social aspirations and indignations, his philosophic speculations and the play of his recreative imagination in evoking the thought and life of a long out-lived past. This fiction, taken chronologically, gives the clue to the development of France out from the dilettant scepticism of Renan, through epicureanism, in its higher and also its lower sense, into an earnest, though still ironic, socialism, with occasional glints of fierce intolerance for obscurantists, reactionary or clerical. Outstanding among these books is first 'Le crime de Sylvestre Bonnard' (1881), his second novel, whose [illegible]ial sympathy with childhood and large-h[illegible]d irony have attracted writers of distinction, among them Lafcadio Hearn, to attempt its translation. 'Balthasar' (1900) and

'Thaïs' (1900), a mediæval and an early Christian study, show a curiously subtle "piety of imagination with impiety of thought." Nearer to his own mind were 'La Rotisserie de la Reine Pédauque' (1893) and 'Les opinions de Jérôme Coignard' (1893) in which the ascetic, epicurean and courtesan figures of Thaïs reappear in 18th century dress and an abbé becomes playful mouthpiece for the ironic expression of a scepticism more radical in France than any since Montaigne. Each book, without plot, is a chain of sparkling epigrams in which the laughing philosopher unmasks the pettinesses and inconsistencies of private and public morals and life. French politics are the unobtruded theme of four notable volumes of Histoire contemporaine, 'L'orme du mail' (1896); 'Le mannequin d'osier' (1897); 'L'anneau d'améthyste' (1899) and 'M. Bergeret à Paris' (1901), all jewels of graceful perversity. Then France's thought takes a more serious bent as he is drawn into the lists with Zola against militarist and religious reaction as revealed in the Dreyfus case. Of this good evidence is seen in 'Crainquebille' (1903); 'Les contes de Jacques Tournebioche' (1908) and the political satires 'L'Île des pingouins' (1908) and 'Les dieux ont soif' (1912) as well as in 'La vie de Jeanne d'Arc' (1908) and in 'Opinions sociales' (1902). All these books, whatever their form, are in effect criticism of contemporary life. He has himself said that he counts criticism as possibly the ultimate evolution of literary expression, well suited to a highly civilized society which is rich in old traditions, the last in date of all literary forms and destined to absorb all. All of them illustrate an idea of style which he has put admirably in 'Le jardin d'Epicure' (1894). "A simple style," he says, "is like white light; it is complex but does not seem so. In writing what appears a beautiful and pleasant simplicity is really the result of careful arrangement and strict economy in the use of the various parts of speech." In this art of hiding his art France is almost supreme. See LE CRIME DE SYLVESTRE BONNARD. Consult an English translation of 'Works' edited by Frederic Chapman (London 1908–19) already embracing 27 volumes. Of separate works there are many other versions. For criticism consult Michaut, G., 'Anatole France,' (Paris 1913), also works by Brandes, G. (London 1908), by George, W. L. (New York 1915), and Shanks, L. P. (Chicago 1919).

BENJAMIN W. WELLS.

THIBAUT, tē-bō, or **THEOBALD I,** king of Navarre: b. France, about 1200; d. 1253. He was educated at the court of Philip Augustus. As the Count of Champagne he is said to have been a lover of the queen of Louis VIII, whose death in 1226 Thibaut was suspected of having caused. He succeeded to the throne of Navarre on the death of his uncle, Sancho the Strong, in 1234. Going in 1239 to Palestine, he suffered defeat at Gaza. He left a reputation in literature as a trouvère whom even Petrarch and Dante, and other great poets praised. His poems, first published by Lévesque de la Ravallière (2 vols., Paris 1742), have appeared in several later editions. Consult Delbarre, 'Vie de Thibaut' (1850), and Lavisse, Ernest, 'Histoire de France' (Vol. III, part VI, Paris 1901).

THIBET, tĭ-bĕt'. See TIBET.

THIBODEAUX, tēb-ō-dō', La., town, parish-seat of Lafourche Parish, on Bayou Lafourche, and on the Southern Pacific Railroad, 47 miles west by south of New Orleans and 60 miles south by east of Baton Rouge. It is in an agricultural region in which the principal products are rice, sugarcane and cotton. The industries are connected chiefly with the cultivation and shipment of cotton, rice, sugarcane and vegetables. It contains foundries, canneries and ice plants. There are several private schools, among them Mount Carmel Academy, Thibodeaux College, and Guion Academy. Pop. 3,824.

THICKHEAD, a South American caterpillar-eating bird of the family *Capitonidæ*, so named because of the full-feathered and apparently excessive size of the head. The family is a large and handsome one, closely allied to the puff-birds, and sometimes united with them under the general term "barbet." In other parts of the world "thickhead" is applied to various other birds, especially in South Africa to the stonecurlew (*Œdicnemus*) of that region, translating the local Dutch name *dikkop*.

THIEF, one who steals or is guilty of theft; one who takes the goods or personal property of another without his knowledge or consent, and without any intention of returning them; one who deprives another of property secretly or without open force, as opposed to a robber, who uses open force or violence. A burglar is a thief who forces an entrance into a building.

THIEF RIVER FALLS, Minn., city, county-seat of Pennington County, on the Great Northern and the Minneapolis, Saint Paul and Sainte Marie railroads, about 50 miles northeast of Crookton on the Red Lake and Thief rivers. It lies in an agricultural section which raises much wheat, has a flour mill, foundry, sash and door factory and iron works. The notable buildings are the Carnegie library and the municipal auditorium. Pop. over 4,000.

THIERRY, tĭ-ĕr'ĭ (Fr. tē-ā-rē), **Amédée Simon Dominique,** French historian and politician: b. Blois, 2 Aug. 1797; d. Paris, 26 March 1873. As a young man he entered the service of the Minister of Marine, and in 1828 became professor of history at Besançon. His ideas being ultra-liberal, his course was suspended by the Minister of Public Instruction. In 1830 he became prefect of the department of Haute-Saône, and in 1838 returned to Paris, where he was appointed master of petitions addressed to the council of state. He held various other political appointments; but continued his historical investigations in the special field he had chosen: the origins of French national history; the early peoples and the neighboring races; and the conquest of the Gauls by the Romans. In 1841 he was elected a member of the Institute; in 1860 he became a senator, and in 1868 he received the cross of the Legion of Honor. His works include 'Histoire des Gaulois' (1828); 'Histoire de la Gaule sous l'administration romaine' (1840–47); 'Histoire d'Attila' (1856); 'Tableaux de l'empire romaine' (1862); Récits de l'histoire romaine au Ve siècle' (1860); 'Saint-Jérôme' (1867), and 'Chrysostome et Eudoxie' (1873).

THIERRY, Jacques Nicolas Augustin, French historian: b. Blois, 10 May 1795; d. Paris, 22 May 1856. He was educated in the Normal School at Paris in 1811, and in 1813 became teacher in a provincial school. The following year he quit this occupation and returned to Paris, where he embraced the socialistic views of Saint Simon, and became his secretary and his coadjutor in literary work, and in 1816 published a treatise of his own, ‹Des nations et de leurs rapports mutuels.› Perceiving the theoretical vagaries of his master, he separated from him in 1817, and became one of the conductors of the journal *Le Censeur Européen.* Shortly afterward he became a contributor to the *Courrier Français,* in which, in 1820, he published 10 letters on the history of France, which attracted attention. His celebrated work on the Norman conquest of England, ‹Histoire de la conquête de l'Angleterre par les Normands,› was published in 1825, and by the interest of the narrative, brilliance of style and novel mode of treating the subject, attained great success both in France and in England. From his close application to work M. Thierry became in the following year almost entirely blind, and at the same time was attacked by a nervous disorder, but still pursued his literary labors. An enlarged edition of the letters formerly written by him for the *Courrier* appeared in 1827, under the title of ‹Lettres sur l'histoire de la France.› In 1830 he was elected a member of the Academy of Inscriptions and in 1834 published ‹Dix ans d'Etudes historiques.› About this time he was entrusted by Guizot, then Minister of Public Instruction, with the editing of the ‹Recueil des monuments inédits de l'histoire du tiers-etat,› for the collection of documents relative to the history of France. To this publication he prefixed an ‹Essai sur l'histoire de la formation du tiers-etat,› separately published in 1853. In 1840 he published ‹Récits des temps métrovingiens,› which gained for him the Gobert prize of the Academy of Inscriptions. There exist translations of his chief works in English. There is a complete edition of his works (10 vols., 1856–60). Consult Valentin, ‹Augustin Thierry› (Paris 1895).

THIERS, tē-ār, **Louis Adolphe,** French statesman and historian: b. Marseilles, 15 April 1797; d. Saint Germain, Paris, 3 Sept. 1877. He studied law at Aix, and was admitted to the bar there in 1818. Desirous of a larger theatre for his ambition he went to Paris in 1821, and having got an appointment on the staff of the *Constitutionnel,* then the leading Parisian journal, he soon attracted attention by his articles in that paper. Journalism soon ceased, however, to supply sufficient stimulus to his active intellect, and he undertook his ‹Histoire de la Révolution française.› having as colleague Felix Bodin, whose name appeared with his in the first two volumes. The work was completed in 10 volumes in 1827. On the formation of the Polignac Cabinet, Thiers founded with Armand Carrel and Mignet, the *National,* whose first number appeared on 1 Jan. 1830. The new democratic organ exercised a decisive influence on public opinion, and the famous ordinances, the signal for the revolution of July, were now issued. Upon this Thiers counseled the issuing by the journalists of a revolutionary manifesto. It was signed by 43 names. To escape arrest Thiers fled, on the night of the 28th, to the neighborhood of Saint Denis, accompanied by Mignet and Armand Carrel. Louis-Philippe, becoming king of the French, Thiers was soon made councillor of state and attached to the department of finance. He was elected deputy for Aix, and after the death of Casimir Périer became Minister of the Interior in the Cabinet of Soult, October 1832. He next filled the offices of Minister of Commerce and Minister of Public Works and again became Minister of the Interior, but in consequence of differences with Soult and Gérard gave in his demission 11 Nov. 1834, but soon resumed office under Mortier. He again retired in February 1836, but a few days after returned to power as foreign minister and president of the council. These offices, after many vicissitudes, he again held in March 1840. Taking a strong interest in the Eastern question he declared in favor of Mehemet Ali of Egypt against Turkey; but neither the king nor the chambers wished to resort to extremities, and the policy of Thiers having received a grave check he retired from the Cabinet 29 Oct. 1840. He now devoted himself to historical pursuits, and his ‹Histoire du Consulat et de l'Empire,› begun in 1845, was completed in 1862, in 20 volumes. The revolution of February, 1848, found him prepared to accept the republic; and he was a member, first of the Constituent and then of the National Assembly. After the *coup d'état* of 1851 he was banished from France, but returned in August, 1852. After an absence of 12 years from public life he was chosen in the elections of 1863 deputy for the department of the Seine, and re-lected in 1869. In this position he regained much of his early popularity. He combated energetically the project of war against Prussia, because France was unprepared, and after the disaster of Sedan visited the courts of London, Vienna, Saint Petersburg and Florence to seek assistance against Prussia, but all that he could obtain was a promise that the four great powers would support the proposal of an armistice. Thiers accordingly proceeded to the headquarters of the king of Prussia at Versailles to open negotiations for peace. But he was unsuccessful, and Prussia proceeded to a war *à outrance.* On 17 Feb. 1871 he was elected chief of the executive power of the republic, and on the 21st opened negotiations with Bismarck, which resulted in the peace with Germany. On 31 August the title of president was bestowed upon him and his term of office fixed at three years. He resigned 24 May 1873, whereupon Marshal MacMahon was appointed president. When MacMahon began to put himself in opposition to the republic, Thiers acted in complete harmony with the republican chiefs of the two chambers, notably with M. Gambetta, to whom, on 3 Sept. 1877, he gave a meeting at Paris to read to him, and to several other politicians, a manifesto which he had just completed. But that very day he was attacked with congestion of the brain and died at night. Thiers was *par excellence* the representative of his country; a witty writer; and an accomplished debater. He was also genial, unselfish, large-hearted; and to establish the glory of France was the main secret of his measures and counsels.

Besides the works already named Thiers was the author of 'Histoire de la loi' (1826, English trans. 1859); 'De la propriété' (1848); 'L'Homme et la matière' (1875). Consult Atkinson, F. M., 'Memoirs of M. Thiers' (New York 1916); Belot. C., 'Le pouvoir exécutif sous le gouvernement de M. Thiers' (Bijon 1908); Le Goff, François, 'The Life of Louis Adolphe Thiers' (New York 1879); Hanotaux, G., 'Le gouvernment de M. Thiers' (Paris 1903); Marcère, E. de, 'L'Assemblée nationale de 1871' (ib. 1904); Simon, P. F., 'Adolphe Thiers: chef du pouvoir exécutif et président de la République Française' (Paris 1911); Zevort, Edgar, 'Thiers' (ib. 1892); Mazade, 'M. Thiers: cinquante années d'histoire contemporaine' (1884); Simon, 'Thiers, Guizot, Rémusat' (1885); Rémusat, P. L. E. de, 'A. Thiers' 'English trans. 1892).

THIEVES' ISLANDS. See LADRONES.

THILLY, Frank, American writer and educator: b. Cincinnati, Ohio, 1865. He was educated in the Ohio University where he graduated in 1887, and completed his studies in Berlin and Heidelberg. For several years he devoted himself to teaching philosophy in Missouri University (1893–1904); psychology at Princeton (1904–06); philosophy at Cornell from 1906 on, finally becoming dean of the College of Arts. He edited the *International Journal of Ethics* (1909) and was president of the American Philosophical Society (1912). He is the author of 'Leibnitz' Controversy with Locke' (1891); 'Introduction to Ethics' (1900); 'The Proceeds of Inductive Inference' (1904); 'A History of Philosophy' (1914). He also has translated Weber's 'History of Philosophy' (1896); 'Poulsen's Introduction to Philosophy' (1885) and 'A System of Ethics' (1899).

THIMBLE, a small metallic sheath or cap used to protect the end of the finger in sewing. Seamstresses use a thimble having a rounded end. Those used by tailors are open at the end. In the manufacture of thimbles coin silver is mostly used, generally silver dollars, which are melted and cast into solid ingots. These are rolled into the required thickness, and cut by a stamp into discs of any required size. A solid metal bar the size of the inside of the intended thimble, moved by powerful machinery up and down in a bottomless mold of the size of the outside of the thimble, bends the circular discs into the thimble shape as fast as they can be placed under the descending bar. The work of brightening, polishing and decorating is done on a lathe. Thimbles are said to have been found at Herculaneum, and were used by the Chinese at a very early period. Their invention in Europe is traditionally ascribed to Nicholas van Benschoten, of Amsterdam, in the 17th century. In mechanics, the name thimble is applied to various fixtures, such as a tubular lining through which a bolt passes, etc.

THIMBLE-EYE, a fish, the chub-mackerel (q.v.).

THIMBLE RIG, or SHELL-GAME, a sleight-of-hand or gambling trick, performed by means of three thimbles and a pea or three nut shells and a small wooden tube or box. The pea being placed on a table and covered with one of the thimbles, the performer proceeds to shift the thimbles, covering the pea now with one, now with another, and offers to bet any bystander that no one can tell under which thimble the pea is. The person betting is seldom allowed to win, the pea being abstracted by sleight-of-hand. In the United States the trick is commonly known as the shell-game and is frequently played at race-track meetings, rural fairs and other gatherings.

THIONVILLE, tē-ôṅ-vēl, or **DIEDENHOFEN,** dē'dēn-hō-fĕn, Lorraine, an important railway centre. 18 miles north of Metz. It stands in a level plain on the Moselle River. Its manufactures comprise gloves, thread and nets; and there are sawmills and tanneries. Thionville is the seat of the Lorraine iron industry. There is some trade in corn, hemp, flax, fruit, vegetables, grain, wine and wood. An important fair is held annually. In the Franco-German War of 1870–71 Thionville was invested after the battle of Gravelotte, and after the fall of Metz it was besieged with vigor. On 25 Nov. 1870, it was occupied by the Germans. It suffered severely by the siege. It was restored to France under the terms of the armistice of 11 Nov. 1918 and confirmed by the Treaty of Paris of 1919. Pop. 14,184.

THIRD CENTURY. The central interest of this period lies in the fact that the Roman Empire at the climax of its power and extent, just when presumably it ought to be consolidating itself for a still greater future, began slowly but surely to crumble under the attacks of the barbarians. Toward the end of the century the Goths in Dacia gave the first hints of that power to defeat Roman armies which portended so clearly the fall of the empire. In the last decade the Saracens, a predatory Arab tribe, who are usually supposed to come into history much later than this, began to make themselves felt. Inspired by Mohammed and unified by religious fanaticism in the 7th century they were to prove more fatal to the empire than even the Goths. The success of the barbarians was favored by the disorder consequent on elections of emperors by the Prætorian guards. Septimius Severus (emperor 193–211) halted the barbarians for a while but Rome's decline and fall was inevitable. Severus reigned with vigor as became "the soldiers' emperor," defeating his competitors Niger and Albinus, but cruelly putting to death large numbers of the adherents of his rivals, thus further demoralizing the time. His reign came in the midst of a financial crisis for the empire during which the government resorted to debasement of the coinage to bolster up its credit. Severus was the first of Rome's rulers to lay the foundation of a great private fortune. As emperor he was an extremely hard worker, always at work by dawn, and devoted long hours every day to the duties of his position. On his return to Rome in 202 he was greeted with a popular reception but refused a triumph and in spite of his fortune always lived very modestly. Like Marcus Aurelius he attempted to found a dynasty and when he died at York (Britain), he bequeathed the empire to his two sons, Caracalla and Geta. Caracalla, having killed his brother, gave a frightful example of imperial misrule. Undoubtedly insane,— nothing else could account for his utter cruelty,— Gibbon terms him "a common enemy of mankind." During their father's lifetime the two sons had used the family fortune in racing and gaming, caring only to associate with gladiators and chariot drivers from the circus. To distract them Septimius planned the conquest of Caledonia and it was this that brought him to Britain, where he erected the wall known by his name between the Forth and the Clyde. After Caracalla had expended the family fortune he went to the greatest length of cruelty and injustice to secure more. One good result of his desire for money was the granting of Roman citizenship to all the provinces so as to secure the right to levy direct taxes and imposts on inheritances (215). In imitation of his father Caracalla visited the various provinces of the empire, but instead of benefiting from his stay, each in turn became the scene of his rapine and cruelties. Having heard that the citizens of Alexandria disapproved his mode of life he ordered a general massacre of the inhabitants. He was finally put to death by his soldiers in the East and was followed by a series of emperors in rapid succession, most of whom met violent deaths. Macrinus, who succeeded Caracalla, was put to death within a year by the soldiers. A feminine intrigue then seated Heliogabalus, an Oriental priest, on the throne. He was worse, if possible, than Caracalla and his name has become a byword for utter viciousness. After four years he was succeeded by Alexander Severus, who meant well and accomplished much, but the rule of Rome was now become a difficult task. He tried the expedient of paying an annual tribute to the Goths to keep them from molesting the empire. This token of weakness had, as might have been expected, exactly the opposite effect. Severus was murdered by a mutiny in the army (235) and was succeeded by Maximinus who bravely led his army against the Dacians and defeated them, but was assassinated by his own people near Aquilia the next year. Balbinus and Gordian reigned very briefly, though Gordian defeated the Persians under Sapor before meeting death from Philip the Arabian who succeeded him in 244.

In 248 Philip was succeeded by Decius who bitterly persecuted the Christians and was slain by the Goths who invaded the empire the following year. The Huns on the Caspian Sea come into history at this time as a new set of enemies for the empire. Emperors continued to succeed each other nearly every year — Gallus (251), Æmilianus (253), Valerian (254) who five years later was defeated, made prisoner and flayed alive by the Persians. Then came Gallienus and the era of the Thirty Tyrants, none of whom deserve particular mention.

The most interesting character of the 3d century is Zenobia, queen of Palmyra (died 274). Her husband, Odeanthus, had set himself up as ruler of Palmyra during the weakness of the empire in the time of the Thirty Tyrants, and she survived to continue his rule. Zenobia claimed to be a descendant from Cleopatra and her beauty was such that, if tradition be true, she far outrivaled the Egyptian queen. For a time during the disturbed state of the Roman Empire, she exercised sway over a large territory, boldly proclaimed herself Queen of the East and bade defiance to Rome. The ruins of Palmyra were among the first to be excavated and studied in modern times and this gave the town a special interest. The Arabs had for long told wonderful tales of a ruined city in the Syrian Desert, but their description was of remains so extensive and magnificent that it seemed that there must be Oriental exaggeration in their accounts. At the end of the 17th century, European travelers reached the site of Palmyra, however, and found that the Arabian stories minimized rather than exaggerated the truth. There was, for instance, a colonnade stretching almost a mile in length and many of the marble columns constituting it are still standing amid the sand of the desert.

Palmyra, as the inscribed monuments show, came into prominence about the beginning of the 2d century. Adrian took the city under his protection and on the occasion of his visit the name was changed to Adrianopolis. It was extremely prosperous a century later, its position between Parthia and Rome enabling it to trade with both. Under Caracalla, Palmyra received the *jus italicum* and became a Roman colony. After this, it was known as an important military post on the eastern confines. When the emperors in the 3d century led armies to the eastern frontiers, Palmyra was a favorite stopping place. Some of the citizens received even the honors of Roman senatorship and one of them, in the disturbed times after the middle of the 3d century, made himself ruler of the city and came to be recognized even by the Romans as having a certain independence. Odeanthus made himself extremely useful in the wars against the Persians and the Syrians and was rewarded by a tacit recognition at least of his domination over all the country from Armenia to Arabia. When absent on his expeditions, his wife, Zenobia, administered the government of Palmyra very successfully. Indeed, Aurelian, in one of his letters, ascribes to her the chief part in all her husband's successful career. She was an Arabian of dark beauty, black flashing eyes, pearly teeth and a strength which enabled her to accomplish marvels of physical endurance. She was as famous, however, for her intellectual talents as for her beauty. She knew a number of Eastern languages as well as Latin and Greek. Longinus, the famous Greek rhetorician whose Essay on the Sublime is so well known, had been her tutor in Greek. He had been invited to the court and remained faithful to her even in her misfortunes, suffering death for his fidelity.

Odeanthus was assassinated probably at the instigation of the Roman Emperor Gallienus, and Rome proceeded to subdue the Palmyrenes who had ventured defiantly to style their ruler "King of Kings and Restorer of the State." Zenobia, nothing daunted, and used to administrative emergency, took up the unequal contest with the Roman Empire. She held Egypt, Syria, Mesopotamia and Asia Minor as far as Ancyra. Other portions of the East were about to join her when the Roman army under Aurelian made its appearance and prevented further defections. In two great battles that were fought, Romans in Zenobia's forces bore the brunt of the losses. Summoned to surrender after the second defeat, she made light of her losses, saying that so far all who had fallen were Romans. Finally, she had to withdraw within the walls of Palmyra and Aurelian, in spite of the handicap of the desert, succeeded in maintaining the siege of the city. Finding further resistance hopeless, Zenobia attempted to escape, hoping to find a refuge in Persia, but betrayed by the influence of Roman gold she was captured. Then Palmyra capitulated. All the treasures of the city were seized but the inhabitants were spared. Zenobia was taken to Rome to grace the conqueror's triumph but after this, instead of being put to death, she was given a villa outside of the city of Rome where she lived peacefully, with her children till her death, making many friends among the Roman nobility of the time. It is probably to her taste that is due the construction of the beautiful architectural monuments of Palmyra which have made the city the subject of so much of interest, while her own life tinged it with romance.

The end of the 3d century, after a long period of anarchy, was occupied by the firm reign of Diocletian, a self-made man, the son of poor parents, who owed his advance to his military genius. He reigned for some 21 years (284–305) and then (see FOURTH CENTURY) resigned and retired to a pleasant country estate not far from Dioclea, his birthplace in Asia Minor. When in the midst of the critical times for the empire which followed his abdication, Maximilian, one of his successors, urged him to take up the imperial mantle again, he replied: «If you could but see the cabbages which I raise in my garden with my own hands, you would no longer talk to me of abandoning this happy spot for the Empire.» As might well be expected, the man who was capable of this could and did give the Roman Empire years of peace and prosperity, stained unfortunately by the persecution of the Christians, but that did not come until the beginning of the 4th century and under the influence of those who shared the empire with him.

While the 3d century produced no great authors a series of men wrote books that have attracted attention ever since. Plotinus (204–270), the well-known Neoplatonic philosopher who studied at Alexandria and afterward taught philosophy in Rome, wrote his 'Enneads' about the middle of the century. He was an eclectic, borrowing from many sources, and is a Neo-Aristotelian as well as a Platonist and deserves the name of Neo-philosopher. His disciple Porphyry (233–305) wrote a life of Plotinus and also of Pythagoras, but is best known for his treatise «Against the Christians,» which was answered by Eusebius at the beginning of the 4th century. It is known to us only from Jerome's commentary and other Christian criticisms. Longinus (210–273), the author of the essay 'On the Sublime' also belongs to this time and spent most of his mature life at the court of Zenobia in Palmyra. He was as we have said her chief counsellor and the instructor of her children but on the fall of Zenobia he was put to death as a traitor by the Emperor Aurelian. Jebb declared the essay 'On the Sublime' one of the best pieces of literary criticism in the Greek language. (See ON THE SUBLIME). Papinian, the greatest civil lawyer of antiquity, and Dio Cassius (155–230), the Greek historian of Rome, both flourished during the first quarter of the century. Dio's whole work in 80 books was in existence in the 10th century, only some 25 books XXVI to LX now remain nearly complete with but fragments of the others.

PRINCIPAL EVENTS OF THE THIRD CENTURY.

208. Septimus Severus invades Caledonia after conquest and establishment of military government in Britain.
211. Septimus Severus builds wall across Britain to exclude the Northern Picts.
217. Assassination of Caracalla.
222. Heliogabalus slain. Alexander Severus reigns.
226. Parthian Empire dissolved. Sassanian Persian Empire founded.
230. Death of Dio Cassius, the Greek historian of Rome.
235. Alexander Severus slain. Maximinus, a herdsman, becomes emperor.
249. Goths invade the Roman Empire, defeat and kill the emperor Decius.
259. The Persians take Valerian prisoner and flay him alive.
261. The Persians capture Antioch.
268. Germans invade Italy. Claudius defeats the Goths. Persians invade Asia Minor. Odeanthus and Zenobia revolt.
270. Death of Plotinus, Neoplatonic philosopher, author of the 'Enneads.'
272. War with Zenobia, queen of the East.
273. Longinus, philosopher and counsellor to Zenobia put to death by Aurelian.
274. Aurelian subdues Zenobia; yields Daria to the Goths.
284. Diocletian and Maximinus joint emperors. The second Roman embassy reaches China.
287. The Celts or Franks settle on the left bank of the Rhine.
292. Galerius and Constantius become coadjutors to Diocletian and Maximinus. The Roman empire divided into four parts.
297. Siege of Alexandria.

JAMES J. WALSH,
Author of 'The Thirteenth Greatest of Centuries.'

THIRD ESTATE. See TIERS-ETAT.

THIRD ORDER. See TERTIARIES.

THIRD PARTIES. See VOTE, VOTERS, VOTING.

THIRD RAIL. See ELECTRICAL TERMS.

THIRD-RAIL SYSTEM, in electric railway construction, a method of supplying trains on an electric railway with current sent through a conductor located on the track and termed a third rail. Being the first electric system for handling heavy traffic, it possesses unusual interest. In starting a train of five cars by electricity, from 500 to 1,200 amperes are required.

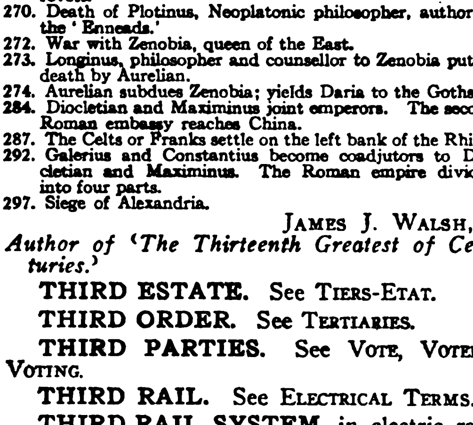


FIG. 1.— Diagram showing typical load carried at power house of Metropolitan Elevated Railway, Chicago, for 24 hours.

If such currents were passed through a trolley wheel, very excessive arcing would be caused, due to the fact that the wheel touches the wire at only one point. The contact surface is not sufficient to carry this current, and burning of the wheel and trolley wire would result. With a sliding shoe, however, instead of a single point of contact, there is a surface about six inches long by two inches wide, and two of these in use at once under normal conditions. The third-rail system differs from the ordinary trolley road only in detail, the principle of operation being similar. These details, however, are such as to make possible the application of electric traction to heavier trains than has been found practicable with the overhead trolley, and the system has thus broadened the field for the application of electricity to railway work, so as to bring it into successful competition with steam for the heaviest classes of service. The reasons for its general adoption on elevated roads were on account of the advantages peculiar to electric traction itself, namely:

1. Reduction in cost of power for handling trains.
2. Increase in passenger handling capacity.
3. A service more attractive to the public generally.

The reduction in the cost of power is obtained largely from the generation of power in a single central steam plant, instead of a great number of smaller plants, as with the steam locomotive system. On this point of economy the fuel bill is one of the large items in the operation of a railroad. With steam locomotives, such as were formerly used on the Chicago elevated roads, the only fuel available cost in the neighborhood of $3.50 to $5.50 per ton, whereas, in the modern power house, designed for electric railway systems, coal ranging from $1.25 to $1.75 a ton was burned with entire success during the period of low prices for coal. When to this is added the enormous loss in radiation from a large number of steam locomotives, exposed as they are in running over the line of the road, and we compare this with the relatively small loss experienced with a well-constructed stationary boiler plant, it is not surprising that the cost for coal per car mile on the electric railways in Chicago is about one-third the cost per car mile with steam locomotives. The comparison is particularly favorable in Chicago on account of the ability to obtain a very cheap grade of coal directly from the Illinois and Indiana coal fields. In New York and other eastern cities, this difference is not so great, as coal delivered at those points is necessarily higher in price on account of larger freight charges. Besides the saving in the coal bill, there is a further gain by the use of large compound-condensing engine units. These large steam units having a comparatively steady load, develop power with a very much lower steam consumption than the small engines of a locomotive with their constant starting and stopping, and consequent cooling of cylinders, etc. Another item in which a considerable saving is made is in the cost of repairs and renewals to the motor equipment as compared with locomotives.

The second advantage — increase in capacity for handling passengers — is due, first, to the fact that with electric motors a much higher rate of acceleration can be obtained in starting trains, thereby increasing the average speed over a given line of road. The trains can also be handled with so much greater accuracy and precision that a much shorter interval is perfectly safe, all of these directly contributing to the end of greater capacity.

The third item — service more attractive to the public generally — is proved by the facts of the absence of smoke and steam, and the great reduction in noise, these being especially important in systems passing through the heart of a large city, as is the case with elevated roads. In regard to the use of the third-rail system on interurban roads, the same general considerations apply as to the economy of operation, except that, trains being less frequent, the economy in the power generation is not so great an item. There is another field for the third-rail electric railway system, which has been developed by the New York, New Haven and Hartford steam road, and that is the use of light trains for suburban and interurban service on many of their branch lines.

One of the most difficult problems in equipping an electric railway system is the proportioning of the total capacity of a power house to the number of cars run, and the subdivision of this total capacity into proper-sized units. In order to determine these points, it is necessary to be able to estimate the maximum loads that will have to be carried during the rush hours and the minimum loads during midday and midnight. The maximum load does not always depend upon the total number of trains run, as on some lines more than half of these trains will be running light in one direction in order to carry the crowds back on their return or vice versa. In subdividing the total capacity of a power house, it is desirable to have a single unit which will carry the minimum light load with reasonable economy. The load on a power house operating in connection with an elevated railway system varies not only from a maximum during rush hours to a minimum during off hours, but also momentarily during the starting and stopping of trains, these fluctuations being most violent when the least number of

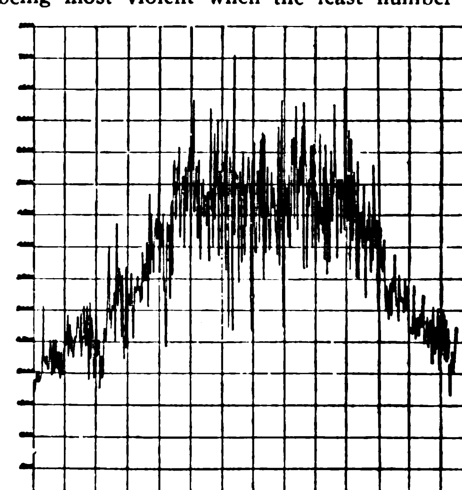


FIG. 2.— Diagram showing fluctuations in the consumption of electrical energy on the Metropolitan Elevated Railway, Chicago, at short intervals from 5 A.M. to 9:30 A.M., ranging from 1,700 to 7,000 amperes.

trains are in service. Under the worst conditions, this rate will vary from 300 amperes to 4,000 in 15 seconds, or the reverse. It is necessary, therefore, that all parts of the engine should be especially heavy, particularly the flywheel, in order that sudden changes in the load should not interfere with the proper regulation of the engine speed.

The accompanying diagram, Fig. 1, shows a typical load curve at the power-house. Curve A is that of the trains in service. Curve B shows the additional amount of energy for heating the cars, with heaters only partly turned on during the rush hours; while curve C gives the total load with heaters turned on full during the rush hours. The high peaks of the curve occur at the rush hours of travel.

The second diagram, Fig. 2, shows the violent fluctuations in the demand for electrical energy for operating the trains.

In the third-rail system the use of the ordinary track rail for the conductor was largely a matter of convenience in the first case, as rails were the easiest form of steel to obtain in reasonable lengths, and their shape was such as to lend themselves to the various requirements of attaching bonds, angle bars and insulating supports. The value of an ordinary commercial steel rail as an electric conductor, as compared with copper, is about 10 or 12 to 1, with of course the additional disadvantage against the rail of the necessity of the frequent bonding, the rails usually coming in 30-foot lengths. To offset this lower carrying capacity, however, compare rails at $17 per ton with copper at $360 per ton, and it can be seen that one can afford to put in the larger amount of steel required for a given electrical capacity and still have a good margin in favor of the rails. A commercial 80-pound track rail has a carrying capacity about equal to an 800,000 centimeter copper cable. In purchasing the contact rails for the extension of a western railway line, they were made of steel of a special chemical composition, having a higher electrical carrying capacity than the ordinary commercial steel rail. The composition was obtained after a series of experiments conducted for the Manhattan Railway in New York, with a view to getting the best possible conductor with a composition of steel that could be successfully rolled into rails. The use of this composition results in a steel rail so soft as to be unfit for ordinary railway service, but the conductivity is raised so that, compared with copper, the ratio is about 8 to 1, as against 12 to 1 for ordinary commercial steel rails.

THIRLMERE, thėrl-mēr, England, a long and narrow lake in the mountains of Cumberland County, in the centre of the Lake District, northwest of Mount Helvellyn, between Derwentwater and Grasmere. It is three miles long by a quarter of a mile wide. The city of Manchester bought and converted it into a reservoir for its water supply, and the system, begun in 1886, was completed in 1894 at enormous expense.

THIRLWALL, thėrl'wâl, **Connop,** English prelate and historian: b. Stepney, Middlesex, 11 Jan. 1797; d. Bath, 27 July 1875. He was educated at the Charter-house and at Trinity College, Cambridge, where he obtained a Fellowship. He afterward studied for the law and was called to the bar in 1825. Having exchanged the law for the church he was ordained in 1828, and some years after received the living of Kirby Underdale, in Yorkshire. Here he added to his pastoral duties a variety of literary labors. The first of his works, published by himself (his father had previously issued a number of essays and poems written by him in extreme youth), was a translation of Schleiermacher's 'Gospel of Saint Luke,' to which he prefixed an introduction. This work appeared anonymously in 1825. His next work was a translation of the first two volumes of Niebuhr's 'History of Rome,' with Archdeacon Hare (1828–31). Then followed the work to which he chiefly owes his reputation, his 'History of Greece,' the first edition of which appeared in Lardner's 'Cabinet Cyclopædia,' in eight volumes, between 1835 and 1844. It was well received, and before the appearance of Grote's history (the first two volumes of which were published in 1846) was without a rival in the English language. Grote himself praises it for the learning, sagacity and candor it displays, and said that if it had appeared a few years earlier he should probably never have conceived the design of his own work. In 1840 Thirlwall was presented by Lord Melbourne to the Welsh bishopric of Saint David's, which he resigned a little more than a year before his death. He was for a time one of the editors of the Cambridge 'Philological Museum,' and during the closing years of his life was a member of the committee for the revision of the Old Testament. He was one of the bishops who spoke and voted for Gladstone's bill for the disestablishment of the Irish Church. Consult Perowne, 'Remains, Literary and Theological, of Connop Thirlwall' (London 1877–80); Thirlwall, 'Essays, Speeches, and Sermons' (1880); Stanley, 'Thirlwall's Letters to a Friend' (London 1882); Morgan, 'Four Biographical Sketches' (1892); Clark, 'Old Friends at Cambridge and Elsewhere' (1900).

THIRST, a craving for water or other drink. As appetite shows a need for the introduction of food into the system, so thirst is a sensation indicating the necessity of an increased supply of water. This sensation is referred to the throat, yet it is not a purely local feeling, but an index of the wants of the tissues at large, for thirst cannot be allayed unless the water swallowed reaches the stomach, is absorbed and carried into the blood. Thirst may also be relieved by the direct introduction of water into blood-vessels or by rectal injections of it, or by its absorption through the skin. How long the demands of thirst may be successfully withstood cannot be stated definitely, since human beings as well as the lower animals differ among themselves, and under varying circumstances of climate, etc., as to the degree of tolerance. Certain it is that of all substances a regular supply of water is most essential to the maintenance of life. If deprived of it for even 8 or 10 hours, greater inconvenience, pain and debility are suffered by an individual than from an equal deprivation of solid food. As thirst is but the expression of a dearth of water in the tissues, any condition which causes a more rapid elimination of water than usual will increase thirst. Such is the effect of severe muscular exercise, especially, for example, the exertion in a heated atmosphere habitual with stokers, iron-puddlers, etc. Thirst is also increased by certain articles of food, excess of salt or sugar, for example: in febrile disorders; in severe diarrhœas and hæmorrhages; in diabetes; in acute gastritis; in polyuria; in certain forms of hysteria, etc.

For allaying thirst nothing is so grateful as pure cool water, sipped a little at a time. Sweet drinks are not as effective in relieving thirst; but the vegetable acids in oranges, lemons, grapes, limes, etc., have a tendency to allay thirst, and to lessen the desire for large quantities of fluid, since the acid provokes an increased flow of saliva. Toast-water, small pieces of ice, effervescent drinks and dilute phosphoric acid alone or combined with a little aromatic bitter are also of value. In fever, cleansing the mouth, and swabbing it with glycerine, borax and water is of more service sometimes than drinking large quantities of water.

THIRTEENTH AMENDMENT. See Constitution of the United States; Constitutional Amendments, History of.

THIRTEENTH CENTURY. John Fiske in 'The Beginnings of New England' terms this period «The glorious thirteenth century» . . . «a wonderful time, but after all less memorable as the culmination of mediæval empire and mediæval church than as the dawning of the new era in which we live to-day.» John Morley said, «I want to know what men thought and did in the thirteenth century — because the thirteenth century is at the root of what men do in the nineteenth century.» Freeman 'The Norman Conquest' calls it «The age of wonders . . . which wrought the body politic of England into a shape which left future ages nothing to do but to improve in detail.» Frederick Harrison in 'A Survey of the Thirteenth Century' declared «Of all the epochs of effort after a new life that of the age of Aquinas, Roger Bacon, Saint Francis, Saint Louis, Giotto and Dante is the most spiritual, the most really instructive, and indeed the most truly philosophical.» It would be hard to find a group of men so different in character, ways of looking at things and individual intellectuality, so concordant in their estimate of an important period of history as these expressions indicate, but similar appreciation might be quoted from Macaulay, Green, Bishop Stubbs, Carlyle, Walter Scott and many others.

The century has been hailed by many as the greatest in the history of humanity. Nothing shows more clearly the recent change in estimation of the Middle Ages than this. No phase of human achievement in the intellectual and artistic side of man is lacking in this age; many are represented by products that surpass all others. In painting and sculpture, in architecture, in the minor arts and crafts, in literature, in philosophy, in education, in social work, even in the building of hospitals and the care of the ailing, and most surprising of all in medical education and surgery, there was a wonderful accomplishment at this time, the history of which was concealed from us until comparatively recent years by an exaggeration of interest in classical antiquity and in the Renaissance. Just in proportion as we have become deeply interested once more in art, architecture, the arts and crafts, in sculpture and handsome public buildings, in the home and the city beautiful, we have learned to realize how many of the ideals we are striving for now were accomplished marvelously in this late mediæval century. Generations which themselves had lost or impaired these higher interests, affected to condemn this old time. It was grouped among the «Dark Ages,» though we now know it to have been in John Fiske's expression one of the «Bright Ages.»

The central interest of the century and its greatest triumph was the Gothic cathedrals. In England and France particularly, but also in Germany and Italy there arose in the early part of the century some of the most beautiful edifices ever built by man. The generations solved the architectural engineering problems of these huge constructions with absolute success. The decoration of them made a universal appeal and for sheer beauty and suitability has never been excelled. The sculpture on the façade of many of these Gothic cathedrals as at Amiens, Chartres, Rheims, is among the greatest plastic work in the history of art. The figure of Christ over the main door at Amiens has been declared the most beautiful presentation of the human form divine ever made. Every phase of cathedral decoration took on the perfection of its sculpture. The carved stone work, the hammered iron of the gates and grilles, the very hinges and latches of the doors, the brass and bronze work in connection with the altar, the bells, the stained glass, all approached perfection so closely that they have been objects of deep admiration ever since whenever men have been profoundly interested in the arts and crafts. The stained glass has never been excelled and is still an object of almost reverential respect, some of it unapproachable in its beauty.

All the fittings and furnishings of the cathedral, even the least obtrusive, partook of the same surpassing qualities. Dark corners were not left unfinished for it was the house of God. Every detail was the object of loving devotion. The needlework of the time is probably the best in history. The cope of Ascoli (*circa* 1280) is looked upon as the most beautiful ever made. The church vestments and hangings were charmingly worked. The precious vessels for the altar were gems of the metal workers' art, of exquisite line and form, delicately finished and appropriately set with jewels. The Mass books, as well as the Books of Hours, used by the educated worshippers, were so beautifully illuminated that they have been marvels ever since and command high prices in the auction-rooms. Manifestly, there was nothing that the people of the time wanted to do well which they did not accomplish with a marvelous perfection. Their domestic and municipal furnishings partook of the same excellence. The very utensils in the kitchen were beautiful as well as useful and the combination of the two qualities in ordinary life has been declared the criterion of culture in the hearts of a people.

The historic life of the century centres around the cathedrals very much as their social life centred around it in the cities and towns. Their education came into existence as the development of cathedral schools and these were usually placed under the rectorship of the chancellor of the cathedral. The *studia generalia,* as the universities were called because they provided education in so many different subjects, grew into their modern form during the courses of the century. At the beginning a few cities, Salerno, Montpelier, Bologna and Paris and one or two others, had rather important schools of special subjects around which various faculties gradually gathered. By the end of the century there were some 20 important universities in our modern sense of the word with large undergraduate departments and as a rule the three graduate departments of theology, law and medicine. The course of study for undergraduates was summed up by Huxley in his inaugural address as rector of Aberdeen University: "I doubt if the curriculum of any modern university shows so clear and generous a comprehension of what is meant by culture as this old *trivium* and *quadrivium*." The seven liberal arts, as the *trivium* and *quadrivium* were also called, constituted the undergraduate university studies of grammar, logic and rhetoric, geometry, astronomy, theology and music.

All of these subjects were treated from a scientific standpoint and these were really scientific universities. The study of the classics as the basis ot undergraduate education did not come in until the Renaissance time. Hence Huxley's candid admiration for these old-time universities so that he did not hesitate to say that "their work brought them face to face with all the leading aspects of the many-sided mind of man." The philosophical teaching particularly anticipated many modern ideas. Matter and form as the explanation of the composition of matter resembles the modern physical chemistry theory that all matter consists of an underlying substratum the same in everything and differentiated into various substances by the dynamic elements which enter into it. The scholastics taught that matter and force could be annihilated by the power that brought them to existence, but not destroyed by any human agency, thus anticipating the modern experimental demonstration of the indestructibility of matter and the conservation of energy. They faced the ethical problems of mankind, especially those which concern social relations, exactly in the same spirit which the modern world, after a rather long interval of failure to recognize human rights as superior to those of property, has come around to again. In writing on capital and labor for our time Pope Leo XIII quoted the ethics of Saint Thomas Aquinas, drawn up more than six centuries before.

The numbers in attendance at the universities at the end of this century were probably larger in proportion to the population of the various countries than at any time in the history of education down to our own day. The universities of Bologna and of Paris had, during the last quarter of the century, more students than any university of modern times. Oxford and Cambridge were more numerously attended than at any time afterward. Some of the students were boys of 12 or 13 but graduation was earlier than with us as it is still in most foreign countries. On the other hand many mature students remained at the university for years listening to a favorite professor or working up some special theme. The literary output of the universities in philosophy and theology as well as from the graduate departments generally was extensive. Original work was encouraged, though it was the subject of severe criticism. Groups at various universities were engaged in encyclopedic research and publication. A series of *summas* of knowledge in general and of special departments was made.

The discipline of the immense numbers of students represented a problem which was solved by sharing disciplinary regulation with students committees chosen by the Nations, that is, the organizations of the students from particular parts of Europe in attendance at the university. The Nations were fraternal unions which helped the student when he first came to the university to orient himself and get settled for his university work. They protected students against impositions and furnished information with regard to courses and professors. Many of the features of modern life at our universities were thus anticipated. Initiations accompanied by hazing were common practices and the Nations provided recreation of various kinds. On the other hand when students were ailing or when remittances from home were delayed by the vicissitudes of the times, help was provided and students were tided over crises in their affairs. A number of abuses crept into university life through these organizations and conflicts between town and gown are noted before the end of the 13th century, but it was later in the historv of universities that these became so intolerable as to demand correction. In the early history of the universities the students were as important a factor at least as the faculty and new universities were often founded by the withdrawal of dissatisfied students to some other town.

The graduate schools were the most important departments of the universities. In theology, Saint Thomas of Aquin or Aquinas has been an authority ever since and the contributions which he made to philosophy have been the subject of enduring interest. There was a magnificent development of law throughout the various countries and a corresponding evolution of the teaching of law. Canon law particularly was taught with a scientific thoroughness unequalled before and unsurpassed since. It became the basis of all European law. The medical schools are, however, the special surprise for our time. Early in the century the Emperor Frederick II made a law for the Two Sicilies requiring students of medicine to spend some three years at the university preliminary to their medical studies, and then four years at medicine, followed by a year of practice with a physician before they were allowed to practise for themselves. That is a modern standard re-established but recently after a long interreguum. Salerno, the first university medical school, set the example in teaching and insisted on the employment of the natural means of cure, fresh air, water, diet, exercise and occupation and diversion of mind. These are all emphasized in the famous *Regimen Sanitatis Salernitanum*, issued at Salerno about the beginning of the century and published in some 300 editions since the invention of printing. It was the most read popular book on medicine for centuries, republished many times even in the last century. The textbooks in surgery extant from this time have been a revelation. The surgery of the four masters of Salerno who collaborated in the work quite after the modern fashion of textbook writing is surprising in its anticipation of modern surgery. We have, besides, the book of Theodoric of Lucca and of Bruno of Longoburgo as well as of William of Salicet, Lanfranc and Mondeville. In these, anæsthesia,— through mandrake and opium,— antisepsis by the use of strong wine — they boasted of union by first intention — and a great many of the operations, especially a whole series of intra-abdominal and intracranial operations, as well as many instruments and modes of treatment considered to be modern are described. In the large, very well-planned hospitals of the time, with finely organized nursing, many operations undreamt of in the intervening centuries until our generation were successfully accomplished, not merely as emergency interventions, but to save suffering and prolong life.

The names of the teachers in these graduate schools, Albertus Magnus, Thomas Aquinas, Roger Bacon, Bonaventure, Duns Scotus and Alexander of Hales, are probably better known than any group of teachers in history. Instead of losing prestige in the course of time they have gained repute in recent years with increase of interest in the mediæval period. Albertus Magnus is the only scholar in history with whose name the adjective great has become incorporated as if it were a family name. He was a man of the widest interests, intent on testing all knowledge carefully. Humboldt pointed out how much he knew about physical geography, physics, climatology and the physiology of plants. Meyer the historian of botany declared "No botanist who lived before Albertus could be compared with him unless Theophrastus with whom he was not acquainted, and after him none has studied plants so profoundly until the time of Conrad Gesner and Cæsalpino." Albert discussed scientifically the Milky Way and its significance, the irregularities in the moon's surface, lunar rainbows, various kinds of refraction and many other problems supposed to be modern. His great pupil Aquinas, adopting Aristotle, laid down the metaphysical principles which are now coming to be recognized as fundamental ideas in the physical and social sciences. Hence a great revival of study of his works. Even more immediately interesting than these to the modern world is Roger Bacon, the international celebration of whose 700th birthday attracted so much attention at Oxford in June 1914. Bacon probably invented gunpowder, suggested that explosives might be used for motor purposes,— boats running without oars or sails and carriages without horses,— discussed the theory of lenses, declared that mathematics and experiment were the two important factors for advance in science; anticipated modern ideas as to Biblical revision, insisted on the value of Greek and Hebrew for education, declared that light travels with appreciable velocity and spoke with assurance of aviation. It is clearer than ever now why the people of his time called him *Doctor Admirabilis,* the admirable teacher.

A feature of 13th century education most interesting for our time is the feminine education of the period. At Salerno in southern Italy women were encouraged to study even medicine during the 12th century and the department of women's diseases was in their charge. We have many licenses to practise medicine in the Two Siciles granted to women at that time still extant. At Bologna at the end of the 12th century the daughter of Irnerius the great teacher of law became an instructor in the law school. All of the Italian universities had women teachers on their staff. The unfortunate Héloïse and Abelard incident at Paris seems to have given a serious setback to feminine education in the universities of the west of Europe, but in Italy the custom established in the 13th continued, and there have been women professors at the Italian universities every century since.

The literature of the century is the proof of the intellectual quality of the time, for it was not only great but widely read. Its value will be best recognized from the fact that probably well-read people know the works of the 13th century better than of any other, except their own, though they are often not quite conscious of the fact, not having noted the dates. The enduring work of the time begins with the Arthur legends put into fine literary form by Walter Map or Mapes, just as the century begins. To him we owe Lancelot. "Like Paris, handsome, and like Hector, brave," but with a fault that makes him even more appealing, so that probably he is the most interesting character of fiction ever created. Then came the ballads of the Cid in Spain, followed by the Nibelungenlied with the Meistersingers and Minnesingers and then the Troubadours and Trouvêres with the Romance of the Rose and Renard the Fox in what we call France, and, finally, the Trovatori in Italy, culminating in Dante who, the greatest of the Trovatori, was just ready to write what has often been proclaimed the greatest poem of all literature, as the century closed. Such other writers as Villehardouin, Joinville, Matthew of Paris, the earliest encyclopedists, Vincent of Beauvais, Thomas of Cantimprato, Bartholomew the Englishman, and such works as that of William of Durandus and Jacobus de Voragine of the Golden Legend, are perennially interesting. The century has also the greatest of the Latin hymns, the 'Dies Iræ,' the 'Stabat Mater,' the marvelously beautiful religious poetry of Saint Francis himself, of Saint Thomas Aquinas, of Bernard of Morlaix and of Saint Bonaventure.

The century saw the publication of what must be considered the first of encyclopedias. Vincent of Beauvais, under the patronage of Louis IX, with the aid of a great many young assistants of the Dominican Order whose expenses were generously defrayed by the king, was enabled to gather an immense amount of information for his time. In spite of the difficulty of hand transcription, his work extends to over 50 of our volumes octavo. The matter is well chosen and of wide interest, and the surprise is how many things supposed to be much more modern in human knowledge are to be found in Vincent. Pagel declared "the reading of the work easily becomes absorbing."

The century provided a magnificent series of contributions by explorers to the knowledge of the world at that time. Travelers in the Near and the Far East told the stories of how other people lived and their books still extant demonstrate what excellent observers they were. The greatest of these explorers was Marco Polo, whose name was for so long a by-word for credulity and tendency to exaggeration, who proves now, like Herodotus, to have had a basis of real truth for all that he told. He visited the Christian kingdom of Abyssinia as well as China and nearly all the world between. He told of Burmah, of Siam, of Cochin China, of Japan, of Java, of Ceylon and India and he had heard interesting accounts of the coast of Zanzibar and distant Madagascar and at the opposite end of the world of Siberia and the shores of the Arctic Ocean. Colonel Yule, a modern authority on the literature of travel, can scarcely find words to praise Polo enough. There were many other famous travelers whose works have come down to us from the century and are republished in recent years. Friar John of Carpini went on a mission to the Tatar emperor of the time, across the Ural Mountains and River, past the northern part of the Caspian Sea, across the Jaxartes, along the Dzungarian lakes to the Imperial camp near the Orkhon River. Friar William of Rubruk or Rubruquis, the account of whose travels was printed by Hakluyt in his collection of voyages at the end of the 16th century, went even further. Some of his observations, as for instance on Chinese writing, are surprising enough, but he has many details of Asiatic nature, ethnography, manners, morals, commercial customs, that were true to life. Friar Oderic a little later traveled through India and then through China to Nankin and Peking, reached the Great Wall, entered Tibet and appears to have visited Lhasa. Sir John Mandeville (15th century) borrowed much from him, as well as from the Præmonstratensian monk Hayton. Most of the men who thus wandered in distant lands were graduates of the universities of the time and while they were credulous with regard to what they heard, very much as Herodotus himself, they could be absolutely depended on for information with regard to things which they themselves had seen.

Besides the intellectual education which came in the cathedral schools and their developments at the universities there was a great phase of popular education along artistic lines which was initiated in the midst of the building of the cathedrals. Most of the beautiful things in the great Gothic churches were made by workmen of the little mediæval towns in which they were built. None of these had more than a few thousand and probably did not average 10,000 inhabitants. Somehow artistic artisans to do all the beautiful work demanded were found and there was the popular taste to appreciate and the diffusion of liberal education to patronize and encourage the making of such beautiful things. There are receipted bills for the payment to village blacksmiths and village carpenters, for iron and woodwork, which we now rank as artistic masterpieces. Practically all the decorations and fittings of their cathedrals were executed by the townsmen themselves and even their bells and stained glass were made at home, not brought from a distance. Transportation difficulties threw them back on themselves and compelled technical developments while transportation facilities in our time have had an opposite effect. To secure the making of such beautiful things there had to be a skilled and well-trained group of artisans. There has probably never been a time when the arts and crafts, in our modern sense of that term, have been so appreciated and cultivated. In this culture the working classes were probably the most important factor. Technical training was provided by the guilds. Boys were apprenticed to trades and crafts of various kinds, and after four or five years of training became journeymen and traveled from place to place to learn the secrets and customs of their craft in the various regions. After two or three years of this on the presentation and acceptance of an example of their work called a masterpiece — this is where this old English word comes from — they were admitted as master workmen into the guild. This represented a degree in technics. The guild training was practically a technical school and as the guilds existed everywhere opportunities for arts and crafts education abounded. Any growing youth who had taste or talent for any form of artistic work could easily secure the opportunity for its development and then, more important still, obtain the chance to do his work in conditions where encouragement and appreciation would come to him. In England at the end of the Middle Ages there were 30,000 guilds (Toulmin Smith), the county of Norfolk alone having 900, the small town of Wymondham having 11 still known by name. One of them possessed a guild hall. All the guilds of the town are said to have been "well endowed with lands and tenements." In Bury Saint Edmunds, Suffolk, there were 23 guilds; Boston, Lincolnshire, had 14 of which the titles and particulars are known and London had a large number. The guild had increased in number greatly from the 13th century but there is definite evidence that most of the important guilds in existence in England at the end of the 15th century had been in existence for several hundred years. During this time they had accumulated very large amounts of money and invested funds of various kinds, not so much from the fees paid by their members as from bequests of various kinds made to them because it was felt that they were doing great good work. Unfortunately it was this accumulation of money that led to their legal destruction, though a few of the London guilds which were spared in the time of Henry VIII on the plea that they were trading or secular associations and not religious organizations have at the present time an income of over $50,000 per year each. The old guilds were trades unions, social clubs, insurance societies, civic organizations, popular entertainment committees, but withal religious sodalities enforcing fulfilment of religious duties yet not permitting the clergy to hold office or dominate policy.

The social history of the time is its most interesting feature for our era. The beginning of the period saw the rise of the two great mendicant orders, the Begging Friars, the Franciscans and Dominicans. A world so deeply intent on commerce as to give rise to Hansa and the great Italian commercial cities was afforded the example of two large bodies of men who took voluntary poverty for their lot so as to be free to do better things in life.

The coming of the Friars in such an age produced a deep impression. Saint Francis is one of the most lovable men of all history. A young man who, during convalescence from a severe illness, learns in Dean Stanley's words that «the world looks very different when viewed from the horizontal,» gets up from it, resolved that the fascination of trifles shall not obscure the good things of life. He proceeded to forget all about himself and his personal interests and found that all the world began to think of him. He got so close to the heart of nature that it is not surprising that we have legends that the birds and the fishes, and even the wolf of Gubbio harkened to him. He gathered around him a group of men forever famous for their absolute simplicity of life and for their refusal to let selfish motives rule them in any way. Such a life might seem too ideal to have any practical influence over mankind, and, above all, too mystical to make any appeal except to a mediæval world, yet literally dozens of lives of Saint Francis have been written in our very busy practical age. Probably never since his own time has there been so many people, and above all so many whose opinion is of value, ready to proclaim Saint Francis one of the most wonderful characters of humanity as in our era of crowded interests. The love for Lady Poverty of the «little poor man of God,» as he loved to call himself, has appealed to all religious and poetic souls ever since. No wonder that Dante has made such a brave figure of him in the 'Divine Comedy,' and placed beside him as equal in influence and power the great founder of the Dominicans.

The development of hospitals in the 13th century has been the subject of much study in the modern time. Virchow particularly has shown that there was probably scarcely a town of 5,000 inhabitants or more in Germany which did not have a hospital. He attributes this great development, more marked even in other countries than in Germany, to Pope Innocent III who founded «the hospital of the Santo Spirito by the old bridge across the Tiber and blessed and dedicated it as the future centre of a universal humanitarian organization.» Pope Innocent summoned Guy of Montpelier to Rome, having heard that he was in charge of the best organized hospital of the time, built Santo Spirito under his direction and then when bishops come to Rome, as they had at regular intervals, he commended the hospital of Santo Spirito to their study and recommended, where it was virtually a command, that there should be a hospital as far as possible like that, according to conditions in each locality, in every diocese in the world. Many of these hospitals were beautifully built. Municipalities constructed them for their citizens and they were public buildings, part of the scheme of the city beautiful which so many mediæval cities cherished. In smaller places hospitals were often built by the nobility and Virchow has called attention to the number of them constructed under the patronage of the family to which Saint Elizabeth of Hungary belonged. Her hospital at Marburg not far from where the beautiful church erected in her honor a few years after her death now stands, was a model for others. The hospital in Siena, added to (14th century) in memory of Saint Catherine, was another centre of charitable influence. The sister of Saint Louis of France, Marguerite of Bourgogne, built a beautiful hospital at Tonnerre, which Viollet le Duc has figured in his 'Dictionary of Architecture.' This shows how well these hospitals solved the problems of hospital construction which we have realized again in the modern time. There was a fine organization of nursing in these hospitals under the care of religious orders of men and women, especially the Augustinians. How well their work was done can be best appreciated from the great development of surgery which took place at this time, for good surgery is impossible without good hospitals and good nursing. Portions of many of these hospitals remain as evidence for what they were.

With a notable development of social service during the century and the opportunity afforded for feminine education, it is not surprising that the names of a series of women of this time are well known, indeed their prestige has been growing constantly in this last generation just in proportion as similar opportunities are afforded in this century. Saint Elizabeth of Hungary is probably the most famous and the beautiful cathedral erected in her honor at Marburg within a few years after her death, one of the handsomest monuments ever raised to a woman, is the testimony of her generation to their affectionate regard for the «dear Mrs. Saint Elizabeth» (Frau Heilige Elisabeth) as they quaintly called her because she was just a wife and the mother of four children who, though she died at 24, had found time to do great good work for the poor around her. Queen Blanche of Castile, the mother of Saint Louis of France, was another wonderful mother of the time. Her great son attributed all that he was to his mother's training. She was an administrator of high ability who lifted France out of a period of threatened anarchy to preserve his kingdom for her boy, and yet declared that she would rather see him dead at her feet than know that he had committed a mortal sin. The great women of the time came not only on thrones but also among the middle classes. Another mother of the time whose name is recalled in veneration was the wife of a London tradesman, Mabel Rich, whose son, Saint Edmund of Canterbury, one of the most sterling characters of the time, a scholarly churchman, made archbishop, went into exile rather than submit to a tyrant king. Edmund tells how the poor around his mother's home in London blessed her for her charity and was quite frank that he owed nearly everything in life to her. Another distinguished Englishwoman whose name has come down to us from this time is Isabella, the famous Countess of Arundel. She did not hesitate to admonish even the king himself, Henry III, when he was violating the liberties of England. Matthew Paris says that with a dignity which was more than that of woman she reminded the king that many times he had extorted money from his subjects and not kept his word and the rights of Englishmen were written down and he was violating them. With the revival of interest in Saint Francis there has come a parallel rebirth of admiration for Saint Clare of Assisi who at the age of 17 left home to have Saint Francis teach her how to live a life that would not be wasted in worldliness. Her mother and sister, who had opposed her vocation originally, joined her in the second order of Franciscans in a few years.

The military and political events of the century have a special significance because as a rule their influence still lives. The Crusades came to an end, the fourth under Boniface, Marquis of Montferrat (1222), the fifth led by King Andrew II (1228), the sixth (1248) and the seventh and last (1270), under Louis IX of France. The Children's Crusade (1212) was one of the sad interludes of an enthusiasm which went beyond reason. Most of the many thousands of children crusaders perished miserably or were sold into slavery by designing leaders. In 1230 the Teutonic Knights in a crusade against the pagan tribes of the Baltic region established themselves in Prussia and laid the foundation of what at the Reformation, through the ambition of a grand master, was to become a duchy, the beginning of modern Prussia. In 1282, Rudolph of Hapsburg, a Swiss noble, elected emperor in the first election held after the reform of the Imperial Electorate and the creation of seven electors, conferred on his sons the duchies of Austria and laid the foundation of the Hapsburg dynasty. All during the century the kings of Aragon were extending their sway over the Spanish Peninsula and the Balearic Islands (1230). After the Sicilian Vespers, a massacre of the French in Sicily by the Sicilians, so-called from its commencement at vespers on Easter Monday (1282), the kingdom of Sicily passed to them. Less than 20 years before (1265) the French under the House of Anjou had ascended the throne of. the Two Sicilies. In 1235 the duchy of Brunswick was formed under the House of Guelph. Five centuries afterward, when reigning in Hanover, the Guelphs were to succeed to the throne of England (George I) where they still reign. The century saw the rise of Florence in importance, the decline of the republic of Pisa, the increase of Venice in power under an aristocracy which became hereditary toward the end of the period and the enfranchisement of the serfs at Bologna. The closing year of the century Pope Boniface VIII proclaimed the first jubilee and the crowds who flocked to Rome to celebrate it were so large that they could not cross the bridge to the Vatican until the rule of the road of keeping to the right was proclaimed, the first time in history there is mention of it.

Everywhere political events were occurring destined to far-reaching significance. Edward I of England to whom the contest between Robert Bruce and John Baliol for the crown of Scotland had been referred as umpire, conferred it upon Baliol on condition that he should receive it as a vassal of England. The Scotch refused to acknowledge any such dependence, for Scotland, to which Magnus of Norway (1266) had ceded the Hebrides, felt its nationality at stake. Baliol was dethroned and fled to Edward who attempted to enforce his rights. William Wallace, the famous hero of Scottish popular poetry, led an insurrection that was joined by Sir William Douglas and Robert Bruce who gathered round them most of the Scots. They were defeated by Edward at Falkirk (1299), but Robert Bruce was proclaimed king and succeeded in maintaining himself until the defeat of Edward II at the great battle of Bannockburn (1306) settled him firmly on the throne.

The foundation of the Ottoman or Turkish Empire (1299) under Othman I in Bithynia led to the consolidation of Mohammedan power to the serious disturbance of Europe. The Turks are historically relatives of the Mongols who had already created the splendid empire of the Seljuks and who from the 11th to the 13th century governed the greater part of the caliphs' dominions in Asia and thus prepared the way for the Ottomans, their successors. The nucleus of their empire was formed in Asia Minor toward the end of the century under Er-Toghrul. Osman or Othman or Ottoman, his son, is looked upon as the founder of the empire.

The century saw the career of the best ruler of all time, Louis IX of France, or Saint Louis as he came to be called. It has been said of him, «Of all the rulers of men of whom we have record in history, he probably took his duties the most seriously with most regard for others and least for himself and his family.» The watchword of his rule was justice, though he made it the aim of his life that men should have justice and education, and when for any misfortune they needed it — charity. For an unjust judge there was short shrift. The old tree at Versailles under which he used to hear the causes of the poor who appealed to him stood for many centuries the living reminder of Louis' efforts to make the dispensing of justice equal to all men. Voltaire, unsympathetic in so many ways, said of him, «Louis IX appeared to be a prince destined to reform Europe if she could have been reformed, to render France triumphant and civilized and to be in all things a pattern for men. A far-reaching policy was combined with strict justice and he is perhaps the only sovereign who is entitled to this praise; prudent and firm in counsel, intrepid without rashness in his wars, he was as compassionate as if he had always been unhappy. No man could have carried virtue further.» Guizot, the French statesman and historian, so little appealed to by the mediæval, said «The world has seen more profound politicians on the throne, greater generals, men of more mighty and brilliant intellect, princes that have exercised more powerful influence over later generations; but it has never seen such a king as this Saint Louis, never seen a man possessing sovereign power and yet not contracting the vices and passions which attend it, displaying upon the throne in such a high degree every human virtue, purified and ennobled by Christian faith. He was an ideal man, king and Christian, an isolated figure without any peer among his successors or contemporaries.» His reign is the history of France for nearly 50 years (1226–70). He influenced not alone France but the other peoples of his time deeply. He was chosen as the umpire in disputes in foreign countries.

Louis' instructions to his son, so emphatic of justice as the great law among men, his deep interest in education, his foundation of the Sorbonne, his beneficence to the University of Paris, his encouragement of art and architecture, La Sainte Chapelle is his monument, as well as his scholarly patronage of men of letters in friendly intercourse, all stamp him as one of the most broad-minded of men.

Two great Spanish monarchs deserve to be mentioned beside Saint Louis. They are Ferdinand (1200–52), the Saint, king of Castile and Leon, whose mother, Berengaria, was the sister of Blanche of Castile, the mother of Saint Louis. To him is due the collection of translations in the vernacular of the *Forum Judicum* or Code of Visigothic laws, which is one of the oldest specimens of Castillian prose extant and the foundation of Spanish jurisprudence. His son, Alfonso X (1221–84) the Wise, is also known as the astronomer because of the Alfonsine tables, a series of astronomical observations compiled by his direction, but better known as the author of the code *Las Siete Partidas,* the basis of modern Spanish law. Ticknor ('History of Spanish Literature') declared that Alfonso «first made Castilian a national language by causing the Bible to be translated into it and by requiring it to be used in all legal proceedings.» Under these two great monarchs, Spanish literature began its magnificent course, the ballads of the Cid and of Bernardo del Carpio becoming the common property of the people.

Surprisingly enough one phase of political history outside of Europe in the century is as important as anything in Europe. Genghis Khan founded the Mogul or Mongol Empire. He was a Tartar (Tatar) chieftain, by name, Temuchin, who on the death of his father succeeded to the Mongol throne at the age of 13 (1175). The chiefs who owed him allegiance were turbulent and restless, and had been restrained by the iron rule of his father. They refused to submit to a mere boy, but Temuchin's mother had the courage and vigor to repress many of them and keep them to their allegiance until Temuchin showed before long that he could rule them himself. He soon extended his sway over neighboring chiefs and in 1206 proclaimed himself emperor, invaded northern China and securing firm footing within the Great Wall soon conquered most of the country. He then turned westward, defeated the Mohammedans who had beheaded his envoys, overwhelming an immense army of nearly half a million, of whom 160,000 were left dead on the field. Pressing westward he besieged Bokhara, capturing it and Samarcand, and then Merv, all of which were sacked and burned. Astrakan was taken, the Russians defeated and Great Bulgaria ravaged. His troops conquered more of India and most of China, so that this one-time chief of a petty Mongol tribe «lived to see his armies victorious from the China Sea to the banks of the Dnieper; and though the empire which he created ultimately dwindled away in the hands of his degenerate descendants, leaving not a wrack behind, we have in the presence of the Turks in Europe a consequence of his rule, since it was the advance of his armies which drove their Osmanli ancestors from their original home in northern Asia and thus led to their invasion of Bithynia under Othman and finally their advance into Europe under Amurath I.»

Representative government developed during the century parallel with other achievements. Magna Charta was signed in 1215; the concluding sentence of chapter 1 runs: «We have also granted to all free men of our kingdom, for us and for our heirs forever; all the underwritten liberties to be had and held by them and their heirs of us and our heirs forever.» Whatever the original intention, this became eventually a grant to all free Englishmen. In 1257 the Provisions of Oxford under King Henry III established the stated recurrence of the great national council of Parliament. In 1265 the Knights of the Shire and the representatives of the townspeople who formed later the House of Commons were admitted to Parliament, while those personally summoned to attend by the king from the great nobles formed the House of Lords. Beginning with 1295, under Edward I, the attendance of the town members became regular, making Parliament really representative of the country. In the meantime, Bracton's 'Digest of the English Common Law' (1282) secured the legal rights of Englishmen of all classes, and forms the basis of law down to our own time in all English-speaking countries.

Nothing of all the accomplishment of the century probably possesses livelier interest for our commercial age than their organization of business in spite of what must have seemed insuperable difficulties to less enterprising times. Trade combinations and municipal affiliations as well as commerce facilities among distant, different peoples were rendered possible and even easy. Some even of the most modern developments of international intercourse were anticipated. Miss Zimmern ('The Hanseatic League,' Stories of the Nations Series) said: «There is scarcely a more remarkable chapter in history than that which deals with the trading alliance or association known as the Hanseatic League. The league has long since passed away, having served its time and fulfilled its purpose. The needs and circumstances of mankind have changed and new methods and new instruments have been devised for carrying on the commerce of the world. Yet, if the league has disappeared, the beneficial results of its action survive to Europe, though they have become so completely a part of our daily life that we accept them as matters of course, and do not stop to inquire into their origin.»

The condition of the great mass of people as the result of the growth of genuine democracy in this period is particularly interesting for our time. Good authorities have declared it the happiest century of human existence. More men and women than probably at any other time enjoyed the blessedness of having found their work and that work eminently satisfying, because it represented an interest of the mind or soul rather than the body. Artistic power and the art impulse were never so widespread, and triumphs of arts and crafts work were made even in very small towns. As for those without special talent the manual workers, Thorold Rogers, in his 'Economic Interpretation of History,' says: «On the whole there were none of those extremes of poverty and wealth which have excited the astonishment of philanthropists and the indignation of working men. The age, it is true, had its discontents . . . but of poverty that perishes unheeded, of willingness to do honest work and a lack of opportunity, there was little or none.»

Wages were very low, according to our standards and money values, but the necessaries of life were proportionately cheap, and the ratio between wages and prices is the all-important consideration. The social improvement which marked the 13th century led to the fixing by statute in the time of Edward III in the early 14th century of the minimum wage of four pence a day and set maximum prices for necessaries of life. A pair of hand-made shoes was four pence, a fat goose two and one-half pence, a fat sheep a shilling and two pence, and a stall-fed ox only 24 shillings. Needless to say this ratio between wages and prices secured the workman against want. An act of Parliament in the 14th century names «beef, pork, mutton and veal as the food of the poorer sort.» Holidays were frequent. Besides the Sundays there were some 35 holy days during the year on which no work was done, and Saturday afternoon was free after the vesper hour, 2 P.M., as also the vigils of all first-class feasts. Standish O'Grady declared this abundance of leisure a source of the greatness of the time. Twice in the world's history, in the 5th century B.C. in Greece and the 13th century A.D., men have spent one-third of their time in leisure in preparation for and in celebration of religious mysteries. In both periods they had the time and the energy to create artistic and intellectual monuments which the world will never willingly let die.

PRINCIPAL EVENTS OF THE THIRTEENTH CENTURY.

1202. The Fourth Crusade led by Boniface, Marquis of Montferrat.
1204. Conquest of Normandy. Constantinople is besieged and taken by the French and Venetians. Baldwin, Count of Flanders, elected emperor of the East. Seat of the Greek empire removed to Nicæa.
1206. Genghis Khan, the Mongol emperor, begins his career of conquest, extending his expeditions from China to Bulgaria.
1208. Pope Innocent III lays an interdict on England. The Albigensian Crusade.
1209. The Inquisition instituted at Avignon to check heresy.
1212. Defeat of the Saracens at Tolosa, Spain. Contests between Moors and Christians arouse the spirit of chivalry. Goths divide into three kingdoms, Castile, Aragon and Portugal. The ill-starred Children's Crusade.
1214. The liberties of Oxford University confirmed by papal authority.
1215. General revolt against the king of England. John I of England forced to sign Magna Charta. Rise of trade guilds and labor unions.
1220. Venice becomes independent. Golden period of commerce. Cities of Venice, Genoa and Pisa furnish ships for the Crusades. Architecture, fine arts and the industries flourish throughout western Europe.
1226. Louis IX, afterward known as Saint Louis, ascends the throne of France. Saint Francis of Assisi, founder of the Franciscan Order, dies.
1227. Death of Genghis Khan.
1228. The Fifth Crusade led by King Andrew II.
1230. Teutonic knights establish themselves in Prussia
1231. Saint Elizabeth of Hungary dies.
1236. Tatars invade Russia.
1245. Alexander of Hales, the "Irrefragable Doctor" of English theology, dies.
1248. Saint Louis IX of France leads the Sixth Crusade.
1252. Death of Ferdinand the Saint, king of Castile and Leon.
1253. The Jews are expelled from France.
1257. The Provisions of Oxford formulated.
1260. Michael Palæologus founds a family of distinguished Eastern emperors.
1261. Recovers Constantinople from Western domination.
1262. The Barons' War in England.
1263. Sir John de Baliol founds Baliol College, Oxford.
1264. Vincent of Beauvais, the encyclopedist of the Middle Ages, dies.
1265. Henry III of England reigns. Deputies of the Commons first summoned to Parliament. The kingdom of the Two Sicilies comes under French domination.
1268. The Mongol-Tatars invade China.
1270. The Seventh and last Crusade. Death of Saint Louis of France.
1271. Marco Polo's travels extend the knowledge of the world.
1272. Edward I crowned king of England.
1274. Saint Thomas of Aquinas, "Prince of Scholastics," dies.
1280. Albertus Magnus, the "Doctor Universalis" of German philosophy, dies.
1280. The Mongol-Tatars conquer China, overthrow the Southern Sung dynasty and establish the dynasty of Yuen. Under Kublai Khan, grandson of Genghis, the grand canal of China is dug.
1282. The Sicilian Vespers. Massacre of the French in Sicily. Conquest of Wales by the English.
1284. Death of Alfonso X, the Wise, of Spain.
1285. Philip IV reigns in France.
1290. The Jews are expelled from England.
1294. Roger Bacon, the "Doctor Admirabilis" of English science, dies.
1295. The English Parliament is organized.
1297. Edward I takes the coronation chair and the records of Scotland to London.
1299. Scotch defeat at Falkirk. The Ottoman or Turkish Empire founded.

JAMES J. WALSH,
Author of 'The Thirteenth Greatest of Centuries.'

THIRTY-NINE ARTICLES, The. See ARTICLES, THE THIRTY-NINE.

THIRTY TYRANTS, (1) a body of Athenian aristocrats, headed by Critias and Theramenes, who undertook to administer the affairs of Athens at the close of the Peloponnesian War, 404 B.C. They put to death their opponents, and set a Spartan garrison in the Acropolis. Later Thrasybulus led the exiled citizens against Athens, defeated the forces of the Thirty, and slew Critias. Democratic government was restored and soon afterward recognized by Sparta. (2) The Thirty Tyrants of Rome were a band of revolutionists who tried to secure the Imperial power during the reigns of Valerian and Gallienus (qq. v.).

THIRTY YEARS' WAR, so called because it lasted from 1618 to 1648, was at first a struggle between Protestants and Roman Catholics, north Germany supporting the former, and southern Germany, with Austria at its head, the latter cause. It gave the Swedes an opportunity to extend their dominion south of the Baltic, it reduced the resources and weakened the power of Austria, and it gained for the northern states of Germany the breathing space needed to develop independent existence. Few wars, however, have been more calamitous in their general effect on the mass of the people and the happiness and progress of mankind. Apart from the horrors which attended the capture of Magdeburg, and other barbarous scenes of the struggle, it reduced the peasantry and most of the townspeople to abject misery; it may be said to have effaced for a time literature and art in Germany, and it magnified the system of petty principalities, since partly effaced as a result of the Napoleonic wars, but still a powerful obstacle in the way of complete German progress.

On the one side were Austria, nearly all the Roman Catholic princes of Germany, and Spain; on the other side were, at different times, the Protestant powers and France. The occasion of this war is to be found in the fact that Germany had been distracted ever since the Reformation by the mutual jealousy of Roman Catholics, Lutherans and Calvinists, which led the Protestant princes to form the Evangelical Union in 1608, against which the Roman Catholic League was formed the following year. Certain concessions had been made to the Protestants of Bohemia by the Emperor Rudolph II (1609), but these were withdrawn by his successor Matthias in 1614, and four years afterward the Bohemian Protestants were in rebellion. Thus began the first part of the long war, the part that is known as the Bohemian War. The Protestant Bohemians were led by the Count of Thurn, and the Union sent an auxiliary corps into Bohemia, under the command of the brave Ernest, count of Mansfeld. Their leaders drove the imperial troops from Bohemia, invaded the archduchy of Austria, and advanced to the gates of Vienna, but unfavorable weather and want of resources compelled the invaders to retreat. Soon after, Ferdinand, with the title of Ferdinand II, was chosen emperor (28 Aug. 1619). He had borne the title of king of Bohemia since the resignation of his cousin Matthias in 1617. The Bohemians, knowing his hostility to Protestantism, had already declared his title to the Bohemian crown void, and offered it to the elector palatine, Frederick V, the head of the Protestant Union, and husband of Elizabeth, daughter of James I of England. Frederick accepted the crown, but he was ill fitted to cope with the difficulties before him, and the great victory of the troops of the League (8 Nov. 1620), under Maximilian of Bavaria, on the Weissenberg (White Mountain), near Prague, which was followed by the flight of the new king, put an end to the Bohemian rebellion, and crushed the Protestant cause in that quarter. Frederick was put under the ban of the empire, his territory was taken from him and bestowed on Maximilian of Bavaria.

Ferdinand had now a favorable opportunity of concluding a peace on moderate terms. But his unsparing treatment of the conquered, and the reactionary proceedings against the Protestants generally, all of whom had been expelled from Bohemia, at last roused the determined opposition of the Protestant princes, who sought and obtained foreign assistance. Aided by supplies of money from England, and by a body of troops from Holland, Count Mansfeld, Christian of Brunswick, and the Margrave of Baden again took the field, and they were joined by Christian IV of Denmark. Mansfeld was defeated by the imperial general Wallenstein at Dessau (25 April 1626), and after a difficult march through Hungary to the lower Danube, died in Bosnia on 30 November in the same year. Meanwhile Christian of Brunswick had also died, and Christian of Denmark had been defeated by Tilly at Lutter am Barenberg (27 Aug. 1626) and compelled to withdraw to his own territory. The allies of Denmark, the dukes of Mecklenburg, were now obliged to flee from their territories, which were taken possession by Wallenstein with the consent of the emperor. Holstein, Schleswig and Jutland also soon fell into the hands of the imperial troops. Pomerania and Brandenburg had detachments forced upon them by Wallenstein. The power of the emperor extended to the Baltic, and to secure this power an attempt was made to seize all the important towns on the coast. Straslund alone made serious resistance, and during a ten-weeks' siege, which was carried on with furious energy (May to July 1628), it baffled all the attacks of Wallenstein, who was at last forced to retreat with great loss. This check thwarted the plans of Wallenstein, and led to a short interruption of the war. In the peace of Lübeck (12 May 1629) Christian of Denmark received back all the territories belonging to him that had been occupied and devastated by the imperial troops, on the condition of promising to interfere no more in the affairs of Germany.

Austria was once more victorious; but the greater its victory the more complete was to be the triumph of the Roman Catholic Church. With this object the emperor issued the Edict of Restitution, in virtue of which all the ecclesiastical foundations and other church property that had been confiscated for the behoof of Protestants since the religious peace of Passau (1552) were to be restored to the Roman Church, and the Calvinists were to be excluded from the benefits of that peace. This ordinance, which threatened to take a large number of bishoprics, and almost all the abbeys and other ecclesiastical foundations of north Germany, out of the hands of those who then held them, filled all Protestant Germany with alarm and prolonged the war. Many princes and towns refused to obey it, and the emperor was obliged, in order to give effect to it, to keep his forces in the field. But these forces did not long remain under the command of Wallenstein. At a meeting of the Electoral College of the empire in August 1630, Ferdinand found it expedient to yield to the general demand for his deposition, and the supreme command of the imperial armies was given to Tilly, who thereupon marched against Magdeburg, which had refused to carry out the edict.

In the meantime a new belligerent appeared on the scene, one whose exploits form the most interesting episode of the whole war. This was Gustavus Adolphus, king of Sweden, who landed on the coast of Pomerania on 24 June 1630. The inducements which led him to mix himself up with the struggle were the desire of protecting Protestantism in Germany, that of establishing the power of Sweden on the coast of the Baltic and that of checking the advance of the power of Austria in north Germany. For this last reason he had the secret support of the French minister Richelieu, who was jealous of the growing power of the house of Hapsburg. Gustavus Adolphus was generally hailed by the inhabitants of the Protestant states of Germany as their deliverer, but the Protestant princes did not extend to him so eager a welcome. Fearing the revenge of the emperor they for the most part refused his offered alliance, and at the diet of Leipzig resolved to maintain a neutral attitude. The old Duke of Pomerania, whose territory had been terribly devastated by the imperial troops, had at once opened his land to him, but the electors of Brandenburg and Saxony refused him a passage through their territories, and while the time was consumed in negotiations the town of Magdeburg, after repeated assaults, was taken and destroyed (20 May 1631). Tilly now threatened Saxony, and the elector, John George I, hastened to conclude, in his own defense, the alliance which he refused in the interests of the Protestant cause. On 17 September (O. S. 7 September) the forces of Tilly and Gustavus Adolphus met at Breitenfeld, close to Leipzig, when the former were completely defeated. Tilly retreated to the south while the Swedish king advanced to the Main and Rhine. Before the end of winter the latter had made himself master of the bishopric of Würzburg and the greater part of the Lower Palatinate, as well as of the towns on the Rhine. In the spring of 1632 he marched by way of Nuremberg to the

Lech, on the banks of which Tilly had taken up a strong position. On 15 April 1632 this position was forced by the Swedes and Tilly was mortally wounded during the engagement. After placing a garrison in Augsburg, Gustavus Adolphus, accompanied by the former Elector Palatine, Frederic V, advanced as far as Munich, the Bavarian capital. Meantime the emperor had in his distress again turned to Wallenstein and induced him by entreaties and great concessions to undertake to levy and command a new army. After a successful operation against the Saxons, Wallenstein joined the Bavarian troops in Bohemia and marched with them into Franconia, where the Swedes had posted themselves strongly not far from Nuremberg. On arriving there Wallenstein took up another strong position in the neighborhood and fortified a camp. Here the two armies lay for months facing each other without coming to a pitched battle; until at last Gustavus found that the resources of the neighborhood were exhausted and resolved to venture upon an attack on the enemy's camp. But in spite of the bravery of the assailants, the attack, again and again renewed, was always repulsed. Gustavus Adolphus was obliged to give up the hope of success in his attempt and soon after he led his troops into Saxony. Thither Wallenstein followed him, and on 16 Nov. (O. S. 6 Nov.) 1632, a battle was fought at Lützen, near Leipzig, in which Wallenstein was defeated, but in which the victorious Swedes lost their king and leader.

After the death of Gustavus Adolphus the direction of the war was assumed by the Swedish Chancellor Axel Oxenstierna, who, in the first place, got the Protestant princes and towns of the Franconian, Swabian and the two Rhenish circles of the Germanic empire to promise in the Heilbronn Convention to uphold the Swedes until the victory of the Protestant cause should be secure. The principal generals who acted under him were Bernhard von Weimar and the Swedish general Horn. France furnished supplies of money. Bavaria was laid waste by the Swedes, who since the death of their king carried on the war in as barbarous a manner as the Imperial troops, who were now quartered in Silesia. In this province and in Bohemia Wallenstein lingered without exhibiting any of the energy that was demanded of him by the imperial court. This slackness, together with other circumstances, caused him to be suspected of entering into treasonable negotiations with the enemy, and Ferdinand ultimately deposed him and placed him under the ban of the empire, in consequence of which he was murdered by some of his own officers (25 Feb. 1634). After this the imperial army moved into Bavaria, and on 6 Sept. 1634, gained a complete victory over Bernhard von Weimar at Nördlingen. Several German princes, the principal of whom was the Elector of Saxony, who had never been well inclined to the Swedes, now thought it convenient to conclude separate peaces with the emperor, and the people generally began to cherish the hope of soon seeing the termination of the war. The separate peace with Saxony, the peace of Prague, was concluded 30 May 1635, and in it Saxony received the whole of Lusatia as a hereditary possession, while the emperor virtually gave up the edict of restitution.

The hopes raised among the people of Germany by this and other separate peaces were far from being confirmed. Germany itself was almost unanimous in desiring peace, but the Swedes thought it to their interest to continue the war in order not to lose the advantages they had gained, and France now determined to take a more active part in the war, with the view of abasing the house of Hapsburg and extending the French frontier to the Rhine. Richelieu promised to the Swedes important aid in money and troops, and the war was renewed with greater vigor than had been shown since the death of Gustavus Adolphus. The Swedish general Banér conquered and rendered desolate Saxony and Thuringia (1636); Bernhard von Weimar took Rheinfelden, Freiburg and Breisach (1638), and formed the scheme of creating for himself an independent principality on both banks of the Rhine, but was stopped short in his career by death in July 1639. In the midst of these events the emperor had died (February 1637), and had been followed by his son Ferdinand III, a man of milder and less energetic temper than his father, but as firmly attached to the Catholic faith, and equally inclined to force it on his subjects.

In the autumn of 1640 the new emperor assembled a diet at Ratisbon to deliberate over the best method of conducting the war, and while this council was sitting, Banér, who had for the last few years been constantly engaged in the east of Germany, conceived the audacious plan of leaving his winter quarters and taking the whole council, along with the emperor, prisoners (January 1641). A sudden thaw prevented the execution of this scheme by melting the ice on which he had hoped to cross the rivers. Banér died during the retreat. He was succeeded in the command of the Swedish army by Torstenson, the ablest of the generals who proceeded from the school of Gustavus Adolphus. Although generally confined by the gout to a sedan chair, he astonished the world by the rapidity of his movements. He vanquished the imperial armies near Leipzig (Breitenfeld 1642), advanced into Moravia with the intention of penetrating into Austria and attacking the emperor in his capital, then suddenly appeared in Schleswig and Holstein and put to flight Christian IV of Denmark, who had lately allied himself with the emperor and brought an army into the field (1643). Later (August 1645), Wrangel, another Swedish general, forced Christian to accept a disadvantageous peace. After his victory over Christian IV, Torstenson again turned south, and having destroyed two imperial armies, one under Gallas and the other under Hatzfeld and Götz, in conjunction with Rakoczy, prince of Transylvania, once more threatened Vienna (1645). But the emperor was again delivered from the danger. The withdrawal of Rakoczy obliged Torstenson to give up his design; and in the following year, worn out by disease, he resigned his command, which was taken up by Wrangel. Meantime the French had been operating on the Rhine and in the west of Germany. After the death of Bernhard von Weimar they had taken his army into their pay. At the head of this army Guébriant obtained several successes, but toward the close of 1643 suffered a severe defeat in which his army was in great part destroyed. He himself was mortally wounded soon after. In the following year neither of the French generals Enghien and Turenne was able to gain any considerable advantage; but on 3 Aug. 1645, the Austrian general Mercy was defeated at Allersheim, near Nördlingen, after which the junction of the French and Swedes was inevitable. Late in the summer of 1646 their united armies advanced through Swabia and Bavaria, and in the armistice of Ulm (March 1647) compelled Maximilian of Bavaria to fall away from the emperor. In the following year further successes were gained and Wrangel was on the point of uniting his forces with those of the other Swedish general Königsmark who had penetrated into Bohemia, when the news reached the armies that the Peace of Westphalia, which had been negotiating for five years at Münster and Osnabrück, was concluded. By a singular coincidence it happened that the last blow of the war was struck at the place where the war originated, Prague. Königsmark had taken one part of the town and was preparing to attack the other when he was stopped by the news of peace. See AUSTRIA-HUNGARY; DENMARK; FRANCE; GERMAN LANGUAGE AND LITERATURE; GERMANY; GERMAN CATHOLICS; GUSTAVUS II ADOLPHUS; SPAIN; SWEDEN; WALLENSTEIN.

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THISBE. See PYRAMUS AND THISBE.

THISTLE, a composite plant of the genera *Carduus, Cirsium, Centaurea, Onopordon* or *Sonchus.* Other related plants are the golden thistle or Spanish oyster-plant (*Scolymus hispanicus*) whose roots are used as a vegetable like salsify and parsnip, which they resemble somewhat closely in flavor; globe-thistles (*Echinops*), often planted in shrubberies and herbaceous borders for their striking effects; blessed thistle (*Cnicus benedictus*) a hardy annual herb useful for rockeries and wild gardens, but commonly regarded as a weed in the Mediterranean region where it is native, and in California where it has escaped cultivation; and the milk-thistle, also called blessed or holy thistle (see SILYBUM), often grown in European gardens for its edible roots, leaves and heads and also for its ornamental qualities. Several plants of other families have sometimes been called thistle from their apparent resemblance to true thistles. The best known of these are probably the blue thistle (*Echium vulgare*) of the *Boraginaceæ,* and the fuller's or clothier's teasel (*Dipsacus fullonum*) and its few related species of the family *Dipsacaceæ.*

Among the best known genera the following species are probably most widely recognized. The Scotch or cotton thistle (*Onopordon acanthium*) is a biennial occasionally grown in America and sometimes seen wild in the Eastern States. It has cottony white spiny foliage and large solitary terminal heads of pale purple flowers. The plants are often six feet tall and are planted in front of dark colored shrubbery. They seem unlikely to prove troublesome as weeds in America. Some of its other popular names are Queen Mary's, silver, Argentine, oat, asses' and down thistle. The Scottish emblem seems more likely to be really the stemless thistle (*Cirsium acaule*) which is common in Scotland. The so-called Canada thistle (*Cirsium arvense*) is a native of Europe. It has become a troublesome weed in fields where methods of cultivation and rotation are faulty, spreading both by its seeds and its perennial creeping root-stocks, every fragment of which is capable of propagating a new plant. Prevention of leaf formation by persistent cultivation is a sure remedy as well as a safeguard. The plant is a slender herb about three feet tall and has numerous small purplish pink flower heads. The bull thistle (*C. lanceolatum*) and the yellow thistle (*C. horridulum*) are also well-known relatives found along roadsides and in fields, especially pastures. The pasture thistle (*Cirsium odoratum*) is found in similar places. The star thistle (*Centaurea calcitrapa,* etc.) bears a resemblance to the blessed thistle. Several related species, notably the corn flower, blue bottle, bachelor's button or bluet (*C. cyanus*) and the dusty miller (*C. cineraria*) are popular garden plants. Three species of sow thistles — the common (*Sonchus oleraceus*), the field (*S. arvensis*) and the spiny leaved (*S. asper*) — are well-known weeds in the United States and the Carline thistle (*Carlina vulgaris*) plays a similar rôle upon poor soils in Europe. The last was so named because tradition says that Charlemagne used its roots medicinally.

THISTLE, Order of the. See ORDERS, ROYAL.

THISTLE-BIRD, the American goldfinch (q.v.).

THISTLE CROWN, the name of a gold coin of James VI of Scotland, of the value of 97.3 cents. It bore on the obverse a rose and on the reverse a thistle, both crowned.

THISTLEWOOD, Arthur, English conspirator: b. Tupholm, Lincolnshire, 1770; d. London, 1 May 1820. He is said to have imbibed anarchistic doctrines from the writings of Paine and from a visit to France before the fall of Robespierre. He entered the army in 1798 and rose to the rank of a lieutenant. After various misfortunes, both natural and the result of gambling and dissipation, he became an active member of the society formed by Thomas Spence, which aimed at revolutionizing all social institutions. He attempted to organize a revolution in 1816 which failed through the efforts of informers, and in 1817 was indicted for treason, but escaped conviction. In 1818–19 he suffered a year's imprisonment for a threatened breach of the peace. After his release he became the principal agent in the memorable Cato Street conspiracy (so called from the meeting-place of the conspirators in London), the object of which was to murder several of the members of the administration at a cabinet dinner, attack either Coutts's or Child's bank, seize the Tower and Mansion House and set up a provisional government. The day selected for carrying out the plot was that fixed for the funeral of George III at Windsor, when all the military would be out of London to take part in the funeral procession. This absurd scheme was betrayed by a man who was ostensibly one of the conspirators and the deepest in Thistlewood's confidence. The projectors were arrested just as they were about to proceed to the execution of their purpose 23 Feb. 1820. Being tried and condemned as a traitor, Thistlewood, with four of his coadjutors, was hanged and decapitated.

THISTLEWOOD CONSPIRACY. See CATO STREET CONSPIRACY; THISTLEWOOD, ARTHUR.

THIVÆ, thē'vē. See THEBES, GREECE.

THOBURN, Isabella, American missionary and educator: b. near Saint Clairsville, Ohio, 29 March 1840; d. Lucknow, India, 1 Sept. 1901. She came of Scotch-Irish parentage. She was educated in the Wheeling Female Seminary, supplemented by a year in the study of art at the Cincinnati Academy of Design. After teaching in the public schools for several years, she spent a year as an instructor in a private school at New Castle, Pa., and, in 1866, became preceptress of the Western Reserve Seminary at West Farmington, Ohio. In 1869, at the organization of the Woman's Foreign Missionary Society of the Methodist Episcopal Church, she was selected as its first missionary, being assigned to work in India, whither her brother, James M. Thoburn (q.v.), had gone 10 years before. In April 1870 she organized a school for native girls at Lucknow with but six pupils and herself as the only teacher. She also engaged in evangelistic, Sunday school and zenana work. The grade of the school thus established was gradually raised as its attendance increased until a full high school course was offered. In response to a demand for still more advanced courses of instruction, classes in the lower collegiate grades were offered in 1887 and, in 1895, after having complied with the rigid requirements of the British Indian government, it was granted a charter as the Lucknow Woman's College. Climatic conditions, which seriously impaired her health, necessitated several extended furloughs, the years 1880–82, 1886–90 and 1899–1900 being spent in America, though they were years filled with activity in behalf of the cause to which her life had been devoted. The name of the Lucknow Woman's College was subsequently changed to that of the Isabella Thoburn Woman's College. Consult Thoburn, Bishop J. M., 'Life of Isabella Thoburn.'

THOBURN, James Mills, American Methodist Episcopal bishop: b. Saint Clairsville, Ohio, 7 March 1836. He was graduated at Allegheny College, Meadville, Pa., in 1857, and soon after entered the ministry. In 1859 he was sent as a missionary to India and until 1908, when he retired, was identified with work in that region. He was elected bishop of India and Malaysia in 1888 and was for six years the editor of the *Indian Witness*. His writings include 'Missionary Addresses' (1887); 'India and Malaysia' (1893); 'The Deaconess and Her Vocation' (1893); 'Christless Nations' (1895); 'The Church of Pentecost' (1901); 'Life of Isabella Thoburn' (1903) and 'The Christian Conquest of India.'

THOBURN, Joseph, American soldier: b. Carrickfergus, Ireland, 29 April 1825; d. Cedar Creek, 19 Oct. 1864. In August following his parents emigrated to America, settling on a farm in Belmont County, Ohio. His education was obtained in the primitive rural schools of the period, supplemented by diligent private study. He became a teacher in the public schools at the age of 17 and later, having advanced to the principalship of a village school, he began the study of medicine. He was graduated from Starling Medical College, Columbus, Ohio, in 1850. After a term as an interne in hospital service, he located for the practice of his profession at Wheelling, (West) Va. At the outbreak of the Civil War he was commissioned surgeon of the first regiment raised in Virginia for the Union service. At the battle of Philippi, its colonel (Benjamin F. Kelley) was seriously wounded and, the other field officers not being available for duty, the command of the regiment devolved upon the surgeon, who continued to act in that capacity until the expiration of its 100-day term of service. When the regiment reenlisted for three years he was commissioned as its colonel. After a year of service as a regimental commander, he was assigned to the command of the Fourth Brigade, Second Division, Third Army Corps, Army of the Potomac, but had to be given an extended leave on account of a severe wound. He was with his regiment throughout the spring and summer of 1862, later being transferred to the Department of West Virginia, where he was again assigned to the command of a brigade. In May 1864 he took part in the disastrous Lynchburg raid. On 22 July 1864 he was assigned to the command of the First Division of the Department of the Kanawha (later known as the Army of West Virginia and also as the Eighth Army Corps), in which capacity he participated in most of the active movements of the Shenandoah campaign, including the battles of Kernstown, Opequan and Fisher's Hill. In the disposition of the forces at Cedar Creek by Gen. Horatio G. Wright (in the absence of General Sheridan) Colonel Thoburn's division was placed in a peculiarly exposed position, over his protest. In the surprise attack with which the battle of Cedar Creek began (19 Oct. 1864), his command was driven from its camp in utter rout at dawn and, while striving to rally his men for defensive action, he fell mortally wounded. A commission as brigadier-general of volunteers was made out to him the day of his death. His remains were buried with full military honors at Wheeling. Consult 'Official Records of the Union and Confederate Armies' (Series I, Vols. 12, 25, 27, 29, 33, 37, 43, 51) and Pond, George E., 'Personal Memoirs of General Philip H. Sheridan' and 'The Shenandoah Campaign.'

THOBURN, Joseph Bradfield, American writer: b. Bellaire, Ohio, 8 Aug. 1866. In 1871 his parents removed to Marion County, Kan., where he was reared on a farm and attended the public schools. He learned the printer's trade and did some newspaper work, after which he entered the Kansas Agricultural College from which he was graduated in 1893. In 1899 he removed to Oklahoma City, where he engaged in newspaper work. He served as secretary of the Oklahoma Territorial Board of Agriculture from December 1902 until July 1905. Since 1907 he has devoted himself largely to the work of research and writing along the lines of local and western history.

From 1913 to 1917 he was connected with the University of Oklahoma as a specialist in research, field-work and collections in local history and anthropology. During this time he did considerable work in the way of excavating prehistoric earth-works, cave dwellings, tumuli, etc., in Oklahoma. In the course of these investigations he secured positive evidence that the natural mounds, so called, which are so abundant in the region immediately west of the lower half of the valley of the Mississippi, the origin of which had long been a subject of dispute among scientists, are of human origin, each tumulus, so far as examined, proving to be the ruin of a timber-framed, dome-shaped, earth-covered human habitation. He has been in the service of the Oklahoma Historical Society since July 1917, being engaged in research, field collections and editorial work. He is the author of a comprehensive history of Oklahoma, published in 1916.

THOLEN, tō'lĕn, Netherlands, an island in the province of Zeeland, north of the Ooster Schelde and 21 miles northwest of Antwerp, contains 47 square miles. It is protected by dikes. The soil is productive and the principal products are wheat, rye, barley, oats, flax, madder, beans and potatoes. Tholen is also the name of the chief town. Pop. 3,254.

THOM, tŏm, **James,** Scottish sculptor: b. Ayrshire, Scotland, 1799; d. New York, 17 April 1850. He was by trade a stonemason and suddenly leaped into notice by his group 'Tam o' Shanter and Souter Johnny,' cut in the sandstone on which he was accustomed to work. This group now forms part of the Burns monument at Doon, near Ayr. It was first exhibited in Edinburgh (1828) and by its success the sculptor was led to move to London, but in 1837 sailed for the United States, where his genius found at last a liberal recognition. Among his best known works is 'Old Mortality' now in Laurel Hill Cemetery, Philadelphia, of which he was induced to make many replicas.

THOMA, tō'ma, **Ludwig,** German satiric novelist and dramatist: b. Oberammergau, 21 Jan. 1867. He attended gymnasia at Munich and Landshut, the Forestry School at Aschaffenburg, and, in order to study law, the universities of Munich and Erlangen, thus obtaining his entire education in Bavaria. For a short time he practised law at Dachau, later at Munich (1897–98), soon relinquishing this career for that of literature. The general tone of his literary work is well indicated by the fact that he has been connected with the humorous and oppositional weekly *Simplicissimus* (q.v.) at Munich, as editor, since 1899. *März,* a more serious periodical (bi-monthly), has also for a time been under his editorship. The cartoons and quips of *Simplicissimus* were one of the mainstays of the German liberals in their fight with the Imperial Government, and it was one of the great disappointments of 1914 to behold the paper assume a more and more chauvinistic attitude after the events of August in that year, supporting the predatory and imperialistic policy of the German government where resistance would have been the proper attitude of a liberal organ. Thoma's own policy presented a similar change: caught in the great wave of chauvinism which the government had efficiently launched, he took part in the patriotic shouting, and incidentally engaged in polemic correspondence with a number of American writers, including George Haven Putnam, who published some of the interchanges of views in American newspapers. But Thoma is too critical and subtle a man to become a chauvinist of the worst type. In his literary work his opposition is directed chiefly against petty social prejudices and, in the political field, to the Roman Catholic Church; in the latter respect he resembles Anzengruber (q.v.) and Rosegger (q.v.), both of whom, like Thoma, bitterly attack the abuses of the petty clergy, not from a Protestant standpoint, but from the usual hostile position of the laity in Catholic countries. The most notable satires on the clergy are the short story 'Der heilige Hies' (Munich 1904), and the bitter novel 'Andreas Vöst' (ib. 1905, 13th ed., 1910). His three best plays, which are very popular on the German stage, are 'Die Lokalbahn,' a comedy (1902); 'Moral,' comedy (1909), and 'Magdalena,' a popular tragedy ('Volksstück,' 1912). Each has as its theme one of the deficiencies of provincial life. 'Die Lokalbahn' pictures the officious bustle of gossiping town officials, who never achieve any results; 'Moral' reveals the low morality of a group of persons who have joined a society for moral uplift in order to be the more effectively cloaked from each other; 'Magdalena' is the story of a girl's gradual shifting from a love-life that is frank and unselfish, and which, therefore, meets with no disapproval from the villagers, to one that is governed by considerations of money, thus causing her ostracism and death. No man has better depicted the life of the small peasant and country townsman in Bavaria than has Thoma.

Other works are 'Agricola' (1897); 'Assessor Karlchen' (1900); 'Witwen' and 'Die Medaille,' comedies (1901); 'Hochzeit,' short stories (1901); 'Grobheiten,' poems (1901); 'Die Wilderer,' short story (1903); 'Lausbubengeschichten,' burlesques of child life (1904; 25th 1,000, 1907); 'Peter Schlemihl' (1906); 'Tanta Frieda' (like 'Lausbubengeschichten,' 1906; 30th ed., 1910); 'Kleinstadtgeschichten' (1908); 'Erster Klasse,' comedy (1910); Lottchens Geburtstag,' a comedy (1911); 'Der Wittiber,' a novel (1911); 'Josef Filsers Briefwechsel,' a satire (1912); 'Das Säuglingsheim,' burlesque (1913). In the 'German Classics' (Vol. XIX, New York 1914), appears a translation of 'Der heilige Hies' (Matt the Holy).

JACOB WITTMER HARTMANN.

THOMAS, Saint, also called **DIDYMUS** (*Tomas* being the Aramaic; *Didymus,* the Greek word signifying "twin"), one of the Twelve Apostles known as THE DOUBTER. He is said to have been a native of Antioch, the twin brother of a sister Lysias, children of Diophanes and Rhoa. Eusebius implies that he was a stepbrother of Jesus and that his real name was Judas. The scene in the Gospel, in which the doubts were at last dissipated, that Thomas had expressed with great vehemence as to the fact of the resurrection, is the chief of the three occasions on which he is prominent (consult John xx, 24–29; Luke xxiv, 36–49). After the crucifixion of Christ it fell to the lot of Saint Thomas to proselytize India, and tradition relates with great circumstantiality that he hesitated to travel there until Jesus appeared to him in a vision and ordered him to go to Gondophares, the Indo-Parthian King, who ruled over the Kabul Valley and the Punjab, and to build him a palace. Saint Thomas accordingly went to India, and converted and baptized the King Gundaphoras or Gondophares whose name is known to archæologists through many inscriptions and coins as reigning from A.D. 21 to 52 at Peshawar on the Indus. Later traditions state that Thomas went farther south and east than the Punjab; founded the Church of the Christians of Saint Thomas in Malabar, and was martyred on Mount Saint Thomas near Madras. (See CHRISTIANS OF SAINT THOMAS). In Ceylon, Saint Thomas shares with Buddha the honor of the footprint on Adam's Peak, reputed as left on his ascension into heaven. His remains were transferred to Edessa where Chrysostom mentions his grave as one of the four genuine tombs of the apostles, the other three being those of Peter, Paul and John. An apocryphal, 'Gospel of Thomas,' is published in Tischendorf's 'Evangelia Apocrypha.' In his 'Zoological Mythology' (1872), Gubernatis states that in the Middle Ages the Germans of Westphalia made the ass the symbol of Thomas the incredulous apostle to apply to all unbelievers and for a long time, even among German youth, the boy who was last to enter school on Saint 'Thomas' day was called the "ass Thomas." See APOCRYPHA.

THOMAS, Albert Ellsworth, American dramatist: b. Chester, Mass., 18 Sept. 1872. He was graduated at Brown University in 1894, and took his A.M. degree in 1895, becoming a newspaper writer directly afterward. He was employed on leading New York papers, including the *Tribune, Post, Times* and *Sun* between the years 1895 and 1909, when he became a dramatic writer and also published a novel 'Cynthia's Rebellion' (1904). His plays include 'Her Husband's Wife' (1910); 'The Divorce Fund' (1911); 'Little Boy Blue' (1911); 'The Big Idea' (1914), etc.

THOMAS, tō-mä, **Ambroise Charles Louis,** French musical composer: b. Metz, 5 Aug. 1811; d. Paris, 12 Feb. 1896. He studied in the Paris Conservatoire, and in 1832 gained the Grand Prix de Rome, which enabled him to continue his studies in Italy. Returning to France he began to write for the Opéra Comique, his first opera being 'La double Echelle' (1837). Among his early operas may be cited also 'Betty' (1846); 'Le Caïd' (1849), and opera bouffe; and 'Le Roman d' Elvire' (1860). He is best remembered, however, by the more serious works of his later years, 'Mignon' (1866); 'Hamlet' (1868), and 'Françoise de Rimini' (1882). He was appointed professor of composition at the Paris Conservatoire in 1852, and in 1871 succeeded Auber as director. His non-operatic works include a 'Messe Solennelle' (1857), a 'Marche Religieuse' (1865), cantatas, and chamber music.

THOMAS AQUINAS. See AQUINAS, THOMAS.

THOMAS, Arthur Goring, English composer: b. Ralton Park, Sussex, 20 Nov. 1850; d, 20 March 1892. He studied at Haileybury College and his musical education was received at Paris, and at the Royal Academy of Music. His opera, 'The Light of the Harem,' was given with acceptance while he was still a student at the academy. In 1883 his second opera 'Esmeralda' was produced at Drury Lane Theatre and was warmly received. In 1885 followed 'Nadeshda' and 'The Golden Web,' the latter being completed by S. P. Waddington and produced at Liverpool in 1893. Besides his operas he composed 'The Sun Worshippers,' a choral ode, 'Out of the Deep,' and 'The Swan and the Skylark,' both cantatas, the latter one being finished by Sir C. V. Stanford. He is commemorated by the Goring Thomas scholarship at the Royal Academy of Music.

THOMAS, Augustus, American playwright: b. Saint Louis, Mo., 8 Jan. 1859. He was a special writer and illustrator on Saint Louis, Kansas City and New York newspapers, and became editor and proprietor of the Kansas City *Mirror* in 1889. He soon left the field of journalism and became a playwright. He is the author of the popular dramas, 'Arizona,' 'In Mizzoura,' 'The Burglar,' 'The Man Upstairs,' 'On the Quiet,' 'The Earl of Pawtucket,' 'The Other Girl,' 'Mrs. Leffingwell's Boots,' 'The Education of Mr. Pipp,' 'Jim Delancey,' 'The Embassy Ball,' 'The Witching Hour,' 'The Harvest Moon,' 'As a Man Thinks,' 'Indian Summer,' 'That Overcoat,' 'The Hoosier Doctor,' 'The Rio Grande,' 'The Copperhead,' etc. He is a member of the American Academy of Arts and Letters and of the National Institute of Arts and Letters, of which he became president in 1914, and from which he received a gold medal for his services to the drama. In 1914 he received the degree of A.M. from Williams College.

THOMAS, Becket. See BECKET, THOMAS.

THOMAS, Calvin, American college professor: b. near Lapeer, Mich., 28 Oct. 1854; d. New York, 4 Nov. 1919. He was graduated at the University of Michigan in 1874, taking his A.B. degree the same year and the degree of LL.D. in 1904. He taught Latin and Greek at the Grand Rapids High School for a while, after which he studied philology at Leipzig in 1877–78. Following this course he devoted himself to the teaching of German, and was professor of that language at Columbia University. He edited a number of the standard German classics for school and college use and wrote extensively on philological subjects for educational and literary publications, besides assisting in the compilation of the New Standard Dictionary. In 1909 he edited an 'Anthology of German literature.'

THOMAS, Charles Spaulding, American lawyer and politician: b. Darien, Ga., Dec. 6, 1849. He removed his family to Michigan in his youth, and was educated in the State university, taking his LL.D. there 1871. He practised law in Colorado, and was chairman of the Democratic national convention at Kansas in 1900. From 1899–1901 he was governor of Colorado, and in 1913 was chosen United States Senator to fill the unexpired term of Charles J. Hughes, deceased. He was reelected for the term 1915–21.

THOMAS, Cyrus, American archæologist and entomologist: b. Kingsport, Tenn., 27 July 1825; d. 1910. He was admitted to the bar in

1851 and practised law for several years, finally entering the Lutheran ministry in 1864. He was naturalist on the United States Geological Survey 1869–74, and professor of natural sciences in the Southern Illinois Normal University 1874–77. He was State entomologist of Illinois 1875–82, and in 1882 he became ethnologist in the United States bureau of ethnology in charge of mound explorations. Of special interest in this latter line are his 'Study of the Manuscript Troano' (1882); 'Notes on Certain Maya and Mexican Manuscripts' (1884); 'Mound Exploration' (1888); 'Prehistoric Works East of the Rocky Mountains'; 'Indians of North America in Historic Times' (with W. J. McGee 1903).

THOMAS, Edith Matilda, American poet: b. Chatham, Ohio, 12 Aug. 1854. She was educated at the State Normal School, Geneva, Ohio. Much of her verse is distinctly above the average, displaying not only very subtle feeling, but great delicacy of expression. She contributed to many periodicals and published in book form 'A New Year's Masque, etc.' (1885); 'The Round Year' (1886); 'Lyrics and Sonnets' (1887); 'The Inverted Torch' (1890); 'Fair Shadow Land' (1893); 'In Sunshine Land' (1895); 'In the Young World' (1895); 'A Winter Swallow and Other Verse' (1896); 'The Dancers' (1903); 'Cassia and Other Verse' (1905); 'The Guest at the Gate' (verse, 1909); 'The White Messenger'; 'The Flower from the Ashes' (1915).

THOMAS, George Henry, American soldier: b. Southampton County, Va., 31 July 1816; d. San Francisco, Cal., 28 March 1870. On his father's side he was of Welsh and English ancestry. His mother was of Huguenot descent. He received this early education at Southampton Academy, near his home, and soon after his graduation was appointed to a cadetship at the West Point Military Academy, by the Hon. John Y. Mason, member of Congress from the Southampton district. He was graduated at West Point in 1840, standing 12th in a class of 42 members, W. T. Sherman being sixth. He was a thoughtful and industrious student at the academy, a characteristic that followed him throughout his later military career. In 1840 he was appointed lieutenant in the Third artillery. He served in the war against the Seminoles in Florida, and later in the Mexican War, and was brevetted captain and major for meritorious services at Monterey and Buena Vista. He was instructor at the Military Academy in 1851–54. In 1852 he was united in marriage with Miss Frances Kellogg of Troy, N. Y. He was commissioned major of the Second cavalry in 1855, and for some years saw duty on the western frontier, and engaged in campaigning against hostile Indians.

Upon the breaking out of the Civil War he espoused the cause of the Union, and was appointed brigadier-general of United States Volunteers. It has been stated that early in 1861, during the period of suspense and uncertainty that preceded the war, he was vacillating in his loyalty to the government, and that he applied for services in the Southern army; but this is not true, as is clearly shown by the facts presented by his biographers, Van Horne, Piatt and Coppee. In June 1861, he was assigned to the command of General Patterson, with the United States forces in the Valley of Virginia, but was soon transferred to the west, and was placed in command of the first division of the Union army in Kentucky. On 19–20 Jan. 1862, he won the first important victory gained by the government forces in the west, signally defeating the Confederates under General Zollicoffer, at the battle of Mill Springs (q.v.), in Kentucky, and was promoted to the rank of major-general of volunteers and thanked by President Lincoln in a complimentary order. At the battle of Stone River (q.v.), near Murfreesboro, his command held the centre of the Union line, where he gave additional evidences of his abilities as a commander, and of his staying qualities as a fighter. At the battle of Chickamauga (q.v.), in September 1863, Thomas commanded the 14th corps composed of three divisions of Rosecrans' army, and at the crisis of the engagement on 20 September he held the left of the general line, and successfully resisted the repeated attacks of the Confederates. About noon the right wing of the army, weakened by the withdrawal of troops to protect Thomas' left flank, gave way before the assaults of Hood and Longstreet. The right of the army was routed, but Thomas reformed his troops on Snodgrass Hill, and with the aid of reinforcements brought forward by General Gordon Granger, and other detachments, checked the onslaught of the victorious Confedrates, repelled their repeated attacks, and held the position until nightfall, when he safely withdrew his forces to Rossville. His defense of Snodgrass Hill was one of the most dramatic events and one of the most deadly struggles of the Civil War. He fairly won the title of the «Rock of Chickamauga,» by which he is so well known.

In the engagement of November 1863, in front of Chattanooga (q.v.), General Thomas' forces stormed the heights of Missionary Ridge and drove General Bragg's army from its strong position on the crest, gaining a complete victory over the Confederates. In the campaign against Atlanta (q.v.) in 1864 Thomas was second in command to General W. T. Sherman, and ably co-operated with that great soldier in accomplishing the brilliant series of successes achieved by the Union army. When General Sherman left Atlanta and marched with his army through Georgia to the sea, General Thomas took command of the Federal forces remaining in Georgia, Alabama and Tennessee, and prepared to meet the Confederate forces under General Hood, then threatening an advance into Tennessee. General Thomas then began the concentration of his forces at Nashville (q.v.). His troops under Schofield and Stanley stayed Hood's advance at Franklin, Tenn., and inflicted terrible losses upon the Confederates, but Hood soon appeared before Nashville and threatened to attack the city. General Thomas was now reinforced by Gen. A. J. Smith's command from Missouri, and a large force of cavalry under Gen. J. H. Wilson. Time was needed for equipping the cavalry and reorganizing the troops. Severe winter weather had set in, and the hills about Nashville were covered with ice and sleet — thus delaying military operations. Meantime the authorities at Washington became impatient at the delay, and ordered Thomas to attack Hood. General Thomas explained and remonstrated, and took due time for preparation. Orders were issued finally relieving Thomas from the command, but before they could be executed he attacked Hood's army and gained one of the most complete and brilliant victories of the war, routing and almost dispersing Hood's forces. General Thomas, by these results, fully vindicated his judgment against all criticism, and received the thanks of the President and Congress for his splendid victory. He was also commissioned a major-general in the regular army.

At the close of the war he was in command of the Department of the Cumberland at Nashville, and was most useful in reorganizing and sustaining the civil laws and government in Tennessee and the adjacent States. His high personal character, executive ability and good judgment were instrumental in establishing peace and good order throughout that section. General Thomas must be credited with a very high order of military ability, and a most honorable place in the history of the Civil War. He made no serious military mistakes, and can be charged with no defeats.

After the closing of the war he was assigned to the command of the Military Division of the Pacific, with headquarters at San Francisco, where he died. His wife survived him but a few years. They had no children. Consult Coppée, Henry, 'Life of General Thomas' (New York 1893); Bradford, Gamaliel, 'Union Portraits' (Boston 1916); Van Horne, T. B., 'Life of Major-General G. H. Thomas' (New York 1882).

THOMAS, George Housman, English illustrator and engraver: b. 7 Dec. 1824; d. Boulogne, France, 21 July 1868. He began life as an apprentice to a wood engraver, and practised that art in Paris, but gave the greater part of his time to book illustration, in which he became very proficient. He lived in the United States in 1846–47, and made designs for banknotes. After his return to England he became draftsman on the *Illustrated London News*. His notable pictures are 'The Queen Giving Medals to Crimean Heroes,' and 'The Queen and Prince Albert at Aldershot.'

THOMAS, Isaiah, American printer and bookseller: b. Boston, 19 Jan. 1749; d. Worcester, 4 April 1831. He was apprenticed to Zachariah Fowles, a Boston printer, with whom he established the *Massachusetts Spy*, of which he soon became sole proprietor. So bold were his Whig editorials that in 1771 he was summoned to appear for alleged sedition. He refused, and the attorney-general, when ordered to prosecute, failed to obtain a bill of indictment from the grand jury. After participation in the skirmish at Lexington, he continued the publication of the *Spy* at Worcester, where it thereafter appeared with the exception of a brief period in 1776–77. In 1788 he opened a bookshop in Boston, with branches in various parts of the United States. Among his publications were the *Massachusetts Magazine* (8 vols., 1789–95); a folio Bible (1791); and several editions of Watts' 'Psalms and Hymns.' He was the founder (1812), first president, and most liberal patron of the American Antiquarian Society. He published a 'History of Printing' (1810), which contains much valuable material. This was reprinted in 1874 by the Antiquarian Society. Consult Lincoln, 'History of Worcester' (1837); Thomas, B. F., 'Memoir of Isaiah Thomas' (Boston 1874); Hill (in Antiquarian Society 'Transactions,' Vols. IX and X, Worcester 1909).

THOMAS, Jesse Burgess, American Baptist clergyman: b. Edwardsville, Ill., 29 July 1832; d. 7 June 1915. He was graduated from Kenyon College in 1850, and practised law in Chicago 1857–62. He was pastor of the First Baptist Church, Brooklyn, 1864–69, of the Michigan Avenue Baptist Church, Chicago, 1869–74, and from 1874–88 was pastor of the First Church, San Francisco. From 1888 he was professor of church history at the Newton Theological Seminary. He published 'The Old Bible and the New Science'; 'The Mould of Doctrine,' etc.

THOMAS, John, American physician and soldier: b. Marshfield, Mass., 1725; d. Chambly, province of Quebec, 22 June 1776. He was sent as surgeon to the army in Nova Scotia in 1746; was on the medical staff of General Shirley's regiment in 1747; but secured an appointment as lieutenant in 1759. In 1760, while commanding a regiment under Amherst, he was engaged in operations against the French at Lake Champlain and at Montreal. He was a delegate to the Massachusetts provincial congress 1774–75 and having, during the Revolution raised a regiment of volunteers, was appointed brigadier-general. He took part in the siege of Boston; forced the British to evacuate Dorchester; and participated in the Canadian campaign.

THOMAS, John Jacob, American writer on agricultural topics and authority on horticulture: b. near Lake Cayuga, 1810; d. 1895. He became widely known for editorial work and was a recognized authority on farm topics. His best known publication is 'The American Fruit Culturist' (1845), the twenty-first edition of which was reprinted in 1909. He also issued a book on 'Farm Implements and Machinery' (1869) and a work on 'Rural Affairs' (9 vols., 1855–81); writings greatly valued in his day.

THOMAS, Joseph, American lexicographer: b. Cayuga County, N. Y., 23 Sept. 1811; d. Philadelphia, 24 Dec. 1891. He was educated at Rensselaer Polytechnic Institute, Troy, N. Y., and at Yale, was graduated in medicine at Philadelphia, and engaged in practice there. He was in India in 1857–58, where he made a study of Oriental languages and later spent four months in Egypt in the study of Arabic. He was subsequently professor of Latin and Greek at Haverford College, Pennsylvania. He was associate editor with Thomas Baldwin of 'A Pronouncing Gazetteer' (1845), which was revised and published as 'A Complete Pronouncing Gazetteer or Geographical Dictionary of the World' (1855); 'A New and Complete Gazetteer of the United States' (1854), etc. He also wrote 'A First Book of Etymology' (1851–52); 'Travels in Egypt and Palestine' (1853); 'A Comprehensive Medical Dictionary' (1864; rev. ed., 1886); 'Universal Pronouncing Dictionary of Biography and Mythology' (1870–71; 3d ed., rev., 1905); and other works.

He contributed the pronouncing vocabulary of proper names to ‘Webster's Unabridged Dictionary.’

THOMAS, Kempis. See KEMPIS, THOMAS À.

THOMAS, Lorenzo, American soldier: b. Newcastle, Del., 26 Oct. 1804; d. Washington, D. C., 2 March 1875. He was graduated from the United States Military Academy in 1823. At the organization of the Adjutant-General's Department he received a major's commission and served as chief of staff of the army in Florida (1839–40) and in the same capacity on the staff of General Butler during the Mexican War. In 1861 he became brigadier-general and adjutant-general of the army and was retired from active service in 1869. He was named Secretary of War by President Johnson in 1868, but did not take office because of the refusal of Stanton to vacate.

THOMAS, Martha Carey, American woman educator and writer: b. Baltimore, Ohio, 2 Jan. 1857. She was educated at Cornell University, where she was graduated in 1877; studied in Johns Hopkins and Leipzig and took the Ph.D. degree at the University of Zürich in 1883. The Western University of Pennsylvania and Brown University have conferred on her the honorary degree of LL.D. She taught English branches in Bryn Mawr College of which she was chosen president in 1895. She also was elected a trustee of Cornell University. She has published ‘Sir Gawayne and the Green Knight’ (1883); ‘The Education of Women’ (1900), and many articles on the higher education of women contributed to standard magazines. Mrs. Mary Garret, a benefactress of Bryn Mawr, left her for educational uses $15,000,000.

THOMAS, Seth, American manufacturer: b. Plymouth Hollow (now Thomaston), Conn., 1 Dec. 1816; d. there, 28 April 1888. He was the son of Seth Thomas (1786–1859), in whose honor Thomaston was named and who began the manufacture of metal-movement clocks. The son greatly enlarged the business, introducing his clocks throughout the world. He manufactured all sorts of timepieces.

THOMAS, Theodore, American musician: b. Esens, East Friesland, 11 Oct. 1835; d. Chicago, Ill., 4 Jan. 1905. He played the violin in public at the age of six and when only 10 made his first public appearance in New York. In his early concert and operatic engagements he appeared with Jenny Lind, Sontag, Grisi and Mario. During 1855–69 he was associated with Mosenthal, Bergmann, Matzka, Bergner and William Mason in successive seasons of chamber-music concerts. In 1864, having organized the orchestra which long went under his name, he began his symphony concerts in New York. These were continued, excepting the interval from 1869 to 1872, until 1878, when he went to Cincinnati to become director of the College of Music. With an orchestra, sometimes of 40 and later enlarged to 60 pieces, he visited the large cities of the East and West, giving concerts of both popular and classical music and did much for the development of musical taste. With his name were associated the biennial musical festivals held in Cincinnati from 1873 to 1898. Festivals of a similar character were held under his direction in Chicago in 1882 and 1884 and in New York in 1882. As early as 1862 he was appointed conductor of the Brooklyn Philharmonic Society; when the New York Philharmonic Society was organized he was chosen its leader, and both positions he retained until 1891 when he made his residence in Chicago and became leader of the permanent orchestra in that city. In 1893 he was appointed musical director of the World's Columbian Exposition. Consult Thomas, Rose Fay, ‘Our Mountain Garden’ (New York 1904; new ed., 1915) and Upton, G. P. (editor), ‘Theodore Thomas: A Musical Autobiography’ (2 vols., Chicago 1905).

THOMAS, Theodore Gaillard, American physician: b. Edisto Island, S. C., 21 Nov. 1831. He was educated at Charleston College and was graduated as a physician in 1852, speedily moving to New York where he served in Bellevue Hospital and became professor of diseases of women in The College of Physicians and Surgeons. He also was surgeon to the Women's Hospital and consulting physician to the Children's Hospital and to Saint Mary's Hospital of Brooklyn. He was a distinguished gynæcologist and president of the American Society of Gynæcologists; honorary member of the London Obstetrical Society and corresponding secretary of the Obstetrical Society of Berlin. He performed the first ovarian operation in the United States and published an account of it in 1870. His work on the ‘Diseases of Women’ (Philadelphia 1868) ran into six editions and was translated into the five modern languages, including the Chinese.

THOMAS, William Henry Griffith, English theologian: b. England, 1861. He was educated at King's College, London, and Christ Church, Oxford, and was ordained a priest of the Church of England in 1885. From 1896–1905 he was vicar of Saint Paul's, London; principal of Wyckliffe Hall, Oxford, 1905–10; was appointed professor of Old Testament theology in Wyckliffe College, Toronto, 1910. He is author of ‘Methods of Biblical Study’ (1902); ‘A Commentary on Genesis’ (3 vols., 1907–08); ‘The Power of Peace’ (1908); ‘Christianity in Christ’ (1909); ‘A Commentary on Romans’ (3 vols., 1911–12); ‘Work of the Ministry’ (1911); ‘The Prayers of Saint Paul’ (1914), etc.

THOMAS, William Widgery, American Ambassador: b. Portland, Me., 26 Aug. 1839. He was graduated at Bowdoin College in 1860 and in 1862 became bearer of dispatches for the government of the United States. He carried a treaty to Turkey; became vice-consul-general at Constantinople and subsequently was appointed acting consul at Galatz, Moldavia, and war-consul at Gothenburg, Sweden. In 1865 he resigned and in the following year was admitted to the Maine bar. In 1869 Mr. Thomas was made commissioner of public lands for the State of Maine and in 1870–73 served as State commissioner of immigration. In 1870 he visited Sweden, returning to America with 51 Swedish colonists and settling them in northern Maine, founding the colony of New Sweden. In 1883–85 Mr. Thomas was Minister Resident of the United States to Sweden and Norway and in 1889–94 and 1897–1905 was Envoy Extraordinary and Minister Plenipotentiary to Sweden and Norway. In 1873–75 he was member of the Maine house of representatives and of the State senate in 1879. He is a public orator of note and has taken part in many celebrations in Sweden and at home; secured Swedish participation in the Louisiana Purchase Exposition of 1904. He has published 'Sweden and the Swedes' (2 vols., 1891); translation of Victor Rydberg's 'The Last Athenian' (1869), and is corresponding member of the Royal Swedish Academy for Literature, History and Antiquities.

THOMAS, W. Va., city, situated in the Fairfax district of Tucker County, near the summits of the Allegheny Mountains and on the Western Maryland Railroad. Mining is the chief industry. The local bank has resources amounting to $500,000. The value of taxable property within the city limits is $1,000,000. The educational establishments include graded and high schools. The city has a modern fire department with motor equipment and has over one mile of brick pavement. The annual receipts and expenses average approximately $11,000. Pop. 3,500.

THOMAS, Gospel of, one of the New Testament apocryphal books written in the early half of the 2d century. It treats of the boyhood of Jesus and represents him as performing miracles; it was used by the Gnostics, and probably in its original form was much more strongly Gnostic in doctrine than now, having been subject to an orthodox revision. The book in its present form is fragmentary. There is a Latin translation and a Syriac version with English translation was published in 1875. See APOCRYPHA.

THOMAS OF CELANO, religious poet: b. Celano in the Abruzzi about 1200; d. about 1255. He was among the earliest followers of Saint Francis d'Assisi, and in 1221 was warden of the Minorite houses of Worms, Mayence and Cologne and provincial of the order for Germany. He returned to Assisi in 1230. There is much reason for thinking that he was the author of 'Dies Ira, Dies Illa' (q.v.). He also wrote the two sequences, 'Fregit Victor Virtualis'; and 'Sanctitatis Nova Signa.' Consult Lisco, 'Dies Iræ, Hymnus auf das Weltgericht' (1844).

THOMAS OF LONDON. See BECKET, THOMAS À.

THOMAS THE RHYMER. See RHYMER, THOMAS.

THOMASIUS, tō-mä'zē-oos, **Christian**, German philosopher and jurist: b. Leipzig, 1 Jan. 1655; d. Halle, Germany, 23 Sept. 1728. He was educated at Frankfort-on-the-Oder, and became professor of law at Leipzig in 1684. In 1687 he substituted the German language for Latin in his lectures, and in the following year established a scientific magazine published in German. The caustic wit with which he criticized educational methods and religious topics of the day, together with his advance views, on theology in particular, aroused a storm of opposition, and he was forced to leave Leipzig. He went first to Berlin and thence to Halle in 1690, where he became one of the founders of the university, in which from 1694 until his death he was professor of jurisprudence. He was among the first to break away from traditional pedantry and mediæval terminology, introduced improved methods of study into various departments of learning and as a jurist took a firm stand against trial and torture for witchcraft. He wrote 'History of Wisdom and Folly' (3 vols., 1693); 'Thoughts and Reminiscences' (1723–26), and other important works. Consult works concerning him by Luden (1805); Wagner (Berlin 1872); Nicoladini (ib. 1888); Kayser (Hamburg 1900); also White, A. D., 'Seven Great Statesmen in the Warfare of Humanity with Unreason' (New York 1910).

THOMASIUS, Gottfried, German theological writer: b. Egenhausen, Württemberg, 1802; d. 1875. He was educated at Halle and Berlin and occupied the chair of theology at Erlangen University from 1842 until he died. He is author of 'Origines' (1837); 'Christi Person und Werke' (1852–61; 3d ed., 1886–88); 'Christlichen Dogmengeschichte' (1874–76; 2d ed., 1886–89) and various similar works. Consult von Stahlin, 'Löhe, Thomasius, Harless' (Leipzig 1887).

THOMASTON, Conn., town in Litchfield County, on the New York, New Haven and Hartford Railroad, 10 miles north of Waterbury on the Naugatuck River. It was built up by the noted clockmaker, Seth Thomas, who removed there in 1813 and established his business. The great clock for Independence Hall, Philadelphia, was made there in 1876. The town has clock and watch factories, a brass rolling mill and cutlery manufactures. Pop. about 4,500.

THOMASVILLE, tŏm'as-vĭl, Ga., town and county-seat of Thomas County, on the Atlanta, Birmingham and Atlantic, the Florida Central and the Atlantic Coast Line railroads; about 10 miles from the Florida boundary and 55 miles south of Albany. It is in an agricultural and stock-raising region. The chief industrial establishments are cotton compresses, cigar factories and creameries. There is a large trade in cotton, pine, tobacco, wool, fruit, vegetables and grain. A branch of the State University, called the South Georgia Agricultural and Mechanical College, is located here. Other educational institutions are the Young's College for Women, founded in 1869, opened in 1871; the Vashti Industrial School for girls, supported by the Women's Home Missionary Society of the Methodist Episcopal Church, South; a normal school for negroes; the graded schools and a public library. Thomasville was settled in the 19th century and received its present charter in 1889. Pop. 6,727.

THOMASVILLE, N. C., city in Davison County on the Southern and the Carolina and Yadkin railroads, 22 miles southeast of Greensboro. A Baptist orphanage is located here. The city has cotton mills, machine shops and furniture and woodworking factories and is growing. Pop. about 4,000.

THOMISM, tō'mĭzm, one of the two great schools of scholasticism, the other being Scotism (q.v.). It derived its name from its founder, Saint Thomas Aquinas, the great Dominican doctor; while Thomism and Scotism are both scholastic in their fundamentals they differ in various conclusions and corollaries chiefly as follows: (1) on the nature of universals; (2) the principle of individuation; (3) the manner in which grace acts on the human will; (4) the proof of immortality of the soul; (5) freedom from original sin in the case of the mother of Christ; (6) the effects of the merits of the Incarnation; (7) certain points on the mode of the efficacy of the sacraments; (8) whether an action may be morally indifferent; (9) on the question of toleration. See AQUINAS, THOMAS.

THOMPSON, Augustus Charles, American Congregational clergyman: b. Goshen, Conn., 30 April 1812; d. 1901. He was educated at Yale University, at Hartford Theological Seminary and at the University of Berlin. His ordination as a Congregational pastor at Roxbury, Mass., took place 27 July 1842. With the Rev. Dr. Rufus Anderson he visited India in 1854 with a deputation from the American Board of Missions and was delegate to the London Missionary Conference in 1878. He lectured on Foreign Missions at Andover Theological Seminary (1877–80), at Boston University (1882) and at Hartford Theological Seminary (1885–86). He is author of numerous memorials including those of Mrs. A. J. Waters (1854); H. M. Mill (1856) and Rev. Dr. Anderson (1880). His larger publications include 'Moravian Missions' (1882); 'Foreign Missions' (1889); 'Protestant Missions' (1894), and 'The Eliot Memorial' (1900). He also published translations in the Marathi and Tamil tongues.

THOMPSON, Benjamin, COUNT RUMFORD, American physicist: b. North Woburn, Mass., 26 March 1753; d. Auteuil, near Paris, 21 Aug. 1814. He entered a Salem counting-house in 1766, later was made major of New Hampshire militia by the English governor, Wentworth, but, charged with being a Tory, fled to Boston, where he was associated with the British officers. He went to England in 1776 as bearer of certain dispatches, and as a reward for his services obtained a situation in the Foreign Office under Lord George Germain. He became Under-Secretary for the Colonies in 1780, and was shortly afterward appointed lieutenant-colonel of the King's American dragoons. Returning to England in 1783, he retired on half-pay. In 1784 he was knighted and went to the Continent. Through the recommendation of the Prince of Zweibrücken (afterward king of Bavaria) he entered into the service of the reigning elector-palatine and Duke of Bavaria, where he effected many important and useful reforms in both the civil and military departments of the state, the latter of which he practically reorganized. As the reward of his success he received from the sovereign of Bavaria various orders of knighthood, was made a lieutenant-general and created count of the Holy Roman Empire, choosing the title Count Rumford from the name of his wife's native town (now Concord, N. H.). He left Bavaria in 1795, and returned to England, where he employed himself in making experiments on the nature and application of heat and on other subjects of economical and philosophical research. He clearly recognized that heat is a mode of motion, and that by a given amount of mechanical work a definite amount of heat may be produced. Among the objects which engaged his attention was the search for a remedy for smoky chimneys, which at that time formed one of the greatest nuisances in the country; and he succeeded in discovering the principles upon which fireplaces and chimneys have since been constructed. He likewise suggested the plan and assisted in the foundation of the Royal Institution, which led to other establishments of a similar description. In 1804 he removed to Paris, where he took up his residence; and, his wife being dead, he married the widow of the celebrated Lavoisier; but the union proved unfortunate and a separation ere long took place. Count Rumford then retired to a country house at Auteuil, about four miles from Paris, and there devoted his time to the embellishment of his domain and to the cultivation of chemistry and experimental philosophy. His investigations respecting the strength of materials and the force of gunpowder led to considerable improvements in artillery, and he also made discoveries in connection with light and illumination. Count Rumford was by no means a man of extensive learning, but he was familiar with the discoveries and improvements of contemporary science, and the industry and perseverance with which he pursued his inquiries enabled him to make some considerable additions to the knowledge of chemistry and practical philosophy. He was the founder and first recipient of the Rumford medal of the Royal Society, and also founder of the Rumford medal of the American Academy of Arts and Sciences, and of the Rumford professorship in Harvard University. His complete works, with a memoir by George E. Ellis, were published by the American Academy of Arts and Sciences (Boston 1870–75). Consult also Slosson, E. E., in 'Leading American Men of Science' (ed. by D. S. Jordan, New York 1910).

THOMPSON, Charles Miner, American editor and author: b. Montpelier, Vt., 24 March 1864. Following his graduation from Harvard in 1886 he became literary editor of the *Boston Advertiser* (1887–90); associate editor of the *Youth's Companion* (1890–1911) and later a part owner and the editor of that journal. He is noted as a writer of stories for boys. His publications include 'The Nimble Dollar' (1895); 'The Calico Cat' (1908); 'An Army Mule' (1910).

THOMPSON, Daniel Greenleaf, American lawyer, psychological and sociological writer: b. Montpelier, Vt., 9 Feb. 1850; d. New York, 10 July 1897. He was graduated from Amherst and was admitted to the bar in New York in 1872 but devoted himself chiefly to sociological work. Amherst conferred on him the Ph.D. degree in 1894. He became noted as a controversial writer and is known chiefly for 'A System of Psychology' (2 vols., 1884); 'Religious Sentiments of the Human Mind' (1888); 'Social Progress' (1889); 'The Philosophy of Fiction in Literature' (1890), and 'Politics in a Democracy' (1893). The latter publication was translated into the Dutch language.

THOMPSON, Daniel Pierce, American author, lecturer, lawyer and politician: b. Charlestown, Mass., 1 Oct 1795; d. Montpelier, Vt., 6 June 1868. He was educated at Middlebury College, where he was graduated in 1820. He began life as a private tutor in Virginia where he studied law and was admitted to the bar in 1823. He settled in Montpelier the following year, held various judicial offices from that time to 1835 when he was authorized by the legislature to compile the laws of Vermont from 1824 to 1834 (1835) and was elected secretary of state (1853–55). He edited the *Green Mountain Freeman* (1849–56) and proved a voluminous writer. His publications include 'The Advocates of Timothy Peacock, Esq.' (1835), a satire on the Anti-Masonic agitation; 'May Martin or the Money Diggers' (1835), a prize story afterward reprinted in London; 'The Green Mountain Boys' (1840); 'The Rangers' (1857); 'Tales of the Green Mountains' (1852); 'Gant Gurley or the Trapper of Lake Umbagog' (1857); 'The Doomed Chief' (1860), founded on the story of King Philip, and other tales based on Revolutionary stories. He left an unfinished novel, 'The Honest Lawyer.'

THOMPSON, David, Canadian explorer: b. London, 30 April 1770; d. Longueuil, 16 Feb. 1857. He was educated at Christ Hospital School and at Oxford. When but 19 he came to America and took service with the Hudson Bay Company in 1789, beginning work as an explorer in the Great Lakes country. In 1798 he discovered Turtle Lake, one of the sources of the Mississippi; in 1807 he crossed the Rocky Mountains and explored the Columbia River. From 1816–26 he was surveying for the Canadian-United States Boundary Commission. His greatest work aside from his surveys was a map of the Canadian Northwest made in 1814. The last years of his life were spent near Longueuil where he died.

THOMPSON, Denman, American actor: b. near Girard, Pa., 1833; d. 1911. His youth was passed in Swanzy, N. H., and he made his debut in Lowell, Mass., in 1852 in the 'French Spy,' in which he played a small part. His success was made in 'Joshua Whitcomb' in 1875, and his greatest popularity won in the 'Old Homestead,' in which he introduced again the character of "Josh Whitcomb" in country life. This had a run of four seasons in New York alone and its success caused Thompson to tour the country. Consult McKay and Wingate, 'Famous American Actors of Today' (New York 1896).

THOMPSON, Sir Edward Maunde, English palæographist and bibliographer: b. Jamaica, 4 May 1840. He was educated at Rugby and University College, Oxford, was appointed assistant in the British Museum in 1861, assistant-keeper of manuscripts in 1871, in 1878 keeper of manuscripts and Egerton librarian, and from 1888 until 1909 he was principal librarian and secretary. In 1898 his official title as a servant of the British Museum was changed to director and principal librarian. He was Sandars reader in bibliography, Cambridge (1895–96; 1905–06). He was knighted in 1895. For the 'Rolls Series' he has edited 'Chronicon Angliæ, 1328–1388' (1874); 'Chronicon Galfridi le Baker de Swynebroke' (1889), and 'Adæ Murimuth Continuatio Chronicorum' together with 'Robertus de Avesbury de Gestis Mirabilibus Regis Edwardi Tertii' (1889); for the Camden Society, 'Letters of Humphrey Prideaux' (1875) and 'Correspondence of the Family of Hatton' (1878); for the Hakluyt Society, 'Diary of Richard Cocks in Japan' (1883); for the Royal Society of Literature, 'Chronicon Adæ de Usk' (1876); and for the Hellenic Society, with Sir R. C. Jebb, a facsimile of the 'Laurentian Sophocles' (1885). In 1893 appeared his 'Handbook of Greek and Latin Palæography.' He has also written 'An Introduction to Greek and Latin Palœography' (1912); 'Shakespeare Handwriting' (1916).

THOMPSON, Elizabeth Rowell, American philanthropist: b. Lyndon, Vt., 21 Feb. 1821; d. Littleton, N. H., 20 July 1899. She was married to Thomas Thompson, a Boston millionaire, in 1845, and during his life engaged with him in philanthropic work. On his death in 1869 she inherited the entire income from his estate, and continued her charitable labors. She was an advocate of temperance reform, wrote a tract, 'Figures of Hell,' which was widely read, and contributed large sums for the furtherance of the cause. She gave $10,000 for an investigation of yellow fever in the South, and purchased and presented to Congress Carpenter's painting, 'Signing of the Emancipation Proclamation by President Lincoln in the Presence of his Cabinet.' She invested more than $100,000 in establishing heads of families in business, founded the town of Long Mont, Kan., and gave to each colonist 640 acres of land and $300. She contributed to the purchase of the Vassar College telescope, and was a generous benefactor of the American Association for the Advancement of Science, of which she was made the first patron. She was stricken with paralysis in 1888 and was afterward unable to continue her philanthropic work. In 1891 she was pronounced insane by a Kansas City jury, and a curator was appointed to the charge of her property in Missouri. She left an estate appraised at $400,000 with no public bequests.

THOMPSON, Francis, English poet: b. Ashton, Lancashire, 1860; d. London, 13 Nov. 1907. He was the son of a Lancashire physician, was educated at Ushaw Roman Catholic College, near Durham, and studied medicine at Owens College, Manchester. He took no interest in medicine, and turning his attention to literary work he went to London. Here after a struggle with poverty and hardship for some five years his work was brought to the attention of Alice Meynell (q.v.) through whose assistance and that of her husband, Wilfred Meynell, Thompson soon achieved reputation as a poet, and his fame steadily increased. Truly an ascetic, he stood alone among contemporary poets both for purity of thought and beauty of expression. He contributed to the critical reviews and published 'Poems' (1893); 'Sister Songs' (1895), and 'New Poems' (1897). Of his prose works, published posthumously, may be mentioned 'Life of Saint Ignatius Loyola' (1909); 'A Renegade Poet, and Other Essays' (1910); 'Life of John Baptist de la Galle' (1911). Consult his 'Works' (3 vols., New York 1913); also Beacock, G. A., 'Francis Thompson' (Marburg 1912); Meynell, E., 'Life of Francis Thompson' (New York 1913); Rooker, K., 'Francis Thompson' (London 1913).

THOMPSON, George, English reformer: b. Liverpool, England, 18 June 1804; d. 7 Oct. 1878. He acquired notoriety during the anti-slavery agitation by lecturing in the British Colonies. His subsequent tour in the United States produced great excitement and caused President Jackson to denounce him in a message to Congress. He was a friend of Garrison, Whittier and others in the anti-slavery movement and visited America several times. His influence aided materially in preventing the recognition of the South by Great Britain during the Civil War. He also took a prominent part in the Anti-corn Law League and the British India Association to secure better government for India; was a member of the British Parliamentary Reform Association, and was elected member of Parliament 1847–52.

THOMPSON, Sir **Henry,** English surgeon: b. Framlingham, Suffolk, 6 Aug. 1820; d. London, 18 April 1904. He was educated at University College, London, and was awarded the Jacksonian prize in 1852 for an essay on 'The Pathology and Treatment of Stricture of the Urethra,' and again in 1860 for an essay on 'The Healthy and Morbid Anatomy of the Prostate Gland.' In 1853 he became assistant surgeon to University College Hospital, surgeon 10 years later, professor of clinical surgery in 1866, and consulting surgeon in 1847. In 1884 he was professor of pathology and surgery to the Royal College of Surgeons. He received numerous honors from foreign countries, was knighted in 1867, and created a baronet in 1899. His works treat mostly of the urinary organs and their diseases, of cremation, and of diet. Among them may be mentioned 'Clinical Lectures on Diseases of the Urinary Organs' (8th ed., 1888); 'The Preventive Treatment of Calculus Disease' (1888); 'Tumors of the Bladder' (1884); 'Cremation, or the Treatment of the Body after Death' (1874); 'Modern Cremation, its History and Practice' (4th ed., 1901), in which he advocates the substitution of cremation for the present method of sepulture; 'On Food and Feeding' (11th ed., 1901). He was also an artist of note, a pupil of Alma Tadema and others, and exhibited pictures at the Royal Academy, the Salon and elsewhere.

THOMPSON, Jacob, American politician: b. Caswell County, N. C., 15 May 1810; d. Memphis, Tenn., 24 March 1885. He was graduated at the University of North Carolina in 1831, admitted to the bar in 1834 and engaged in law practice in Chickasaw County, Miss., in 1835. He was a member of Congress in 1839–51, and opposed the Compromise of 1850 as not sufficiently favorable to the South. He was appointed Secretary of the Interior by President Buchanan in 1857, and in December 1860, while still holding that office, he was appointed a commissioner from Mississippi to urge upon North Carolina the adoption of a secession ordinance. In January 1861 he resigned from the Cabinet in consequence of the action of President Buchanan in sending reinforcements to Fort Sumpter, which he declared to be a violation of an understanding with the Cabinet that the order should not be given without the knowledge of that body. He took an active part in the subsequent secession movement, was governor of Mississippi in 1862–64 and later served as aide to General Beauregard and inspector-general for the Department of Mississippi. He was Confederate commissioner to Canada in 1864, and a promoter of the plan to seize Chicago and release the prisoners at Camp Douglas near that city. He was accused of being the instigator of plots to burn various Northern cities, also of complicity in the assassination of President Lincoln. A price was put upon his head and he fled to Europe. He returned to the United States, but was not brought to trial.

THOMPSON, James Maurice, American author: b. Fairfield, Ind., 9 Sept. 1844; d. 15 Feb. 1901. He was educated in Georgia, and served in the Confederate army during the Civil War. Afterward he settled in Indiana and practised law and civil engineering at Crawfordsville. Out-door life was his passion, and from 1885 to 1889 he was State geologist of Indiana and chief of the Department of Natural History. In 1890 he joined the staff of the New York *Independent.* His books are the records and observations of a nature-lover rather than a scientist, the product of his trips to the lake and swamp regions of Florida and Louisiana and to the hills of Alabama, Mississippi and Georgia. He was expert with the bow and arrow, with which he hunted instead of a gun. He wrote 'The Witchery of Archery' (1878); 'His Second Campaign' (1882); 'By-Ways and Bird Notes' (1885); 'The Boy's Book of Sport' (1886); 'Sylvan Secrets' (1887); 'Poems' (1892); 'The Ocala Boy' (1895); 'My Winter Garden' (1900); 'Alice of Old Vincennes' (1900).

THOMPSON, Sir **John David Sparrow,** Canadian jurist and for some time Premier of the Dominion: b. Halifax, 10 Nov. 1844; d. Windsor, England, 12 Dec. 1894. His father, who had come from Waterford, Ireland, held the office of queen's printer. Thompson was educated at the common school, Halifax, and was called to the bar in that city in 1865. He joined the Roman Catholic Church in 1871. After holding several municipal offices, he was elected to the Nova Scotia assembly for Antigonish (1877). His success at the bar earned him the dignity of queen's counsel in 1879. He was attorney-general in 1878 and premier of the province in 1879. After the defeat of his government in the same year Thompson was made a judge of the Supreme Court of Nova Scotia. This position he resigned to accept the portfolio of Minister of Justice in Sir John A. Macdonald's Cabinet (1885), entering the Dominion Parliament as member for Antigonish. He remained Minister of Justice until 1892, distinguishing himself by his oratorical power and his untiring industry. In 1887 he visited Washington as one of the commissioners on the fisheries question. The honor of knighthood was conferred on him in August 1888. Sir John again visited Washington as one of the representatives of his government in the unsuccessful reciprocity negotiations of 1891 and 1892. He is understood to have been offered the position of Premier on the death of Sir John A. Macdonald (1891), but preferred to remain as Minister of Justice under the leadership of Sir J. J. C. Abbott. On the retirement of the latter (December 1892) Sir John Thompson became Prime Minister. His incessant Parliamentary labors rapidly undermined his health and brought about his death under singularly tragic circumstances. Visiting England in 1894 to be sworn in as a member of the privy council, he expired suddenly of syncope almost immediately after the ceremony. Consult Hopkins, 'Life and Work of the Rt. Hon. Sir John Thompson' (Toronto 1895).

THOMPSON, John Reuben, American journalist and poet: b. Richmond, Va., 23 Oct.

1823; d. 30 Oct. 1873. He was graduated from the University of Virginia in 1844; practised law in Richmond in 1847, but soon entered on a literary career and for 12 years edited the *Southern Literary Messenger* to which Donald G. Mitchell contributed his 'Reveries of a Bachelor.' Ill health caused his removal to Augusta, Ga., where in 1859 he edited the *Field and Fireside* magazine. Driven to London by events of the Civil War he actively defended the Confederacy in contributions to English magazines. At the close of the war he returned to America and became editor of the New York *Evening Post*. He was author of several poems which were popular at the time.

THOMPSON, Joseph Parrish, American clergyman and Oriental scholar: b. Philadelphia, 7 Aug. 1819; d. Berlin, Germany, 20 Sept. 1879. He was graduated at Yale 1838, studied theology at Andover and Yale seminaries (1839–40) and was ordained Congregational minister the latter year. He became pastor in New Haven (1840–45); New York, Broadway Tabernacle (1845–71). He lectured on Egyptology at Andover in 1871. In 1872 he assisted in establishing *The Independent*; Harvard gave him the degree of D.D. in 1856; The University of New York the degree of Ph.D. in 1857. He pursued his Oriental studies in Berlin (1872–79) and died there. He published several memoirs, including those of Timothy Dwight and David Hale. Also 'Lectures to Young Men' (1846); 'Egypt Past and Present' (1856); 'Genesis and Geology' (1869); 'Church and State in the United States' (1874); 'The United States as a Nation' (1877); 'The Workman: His False and His True Friends' (1879). His political and social essays were collected and published under the title of 'American Comments on European Questions' (1884).

THOMPSON, Launt, American sculptor: b. Abbeyleix, Ireland, 8 Feb. 1833; d. Middletown, N. Y., 26 Sept. 1894. He arrived in the United States 1847, and began his study of sculpture under Erastus Dow Palmer in Albany. In 1857 he removed to New York where he opened a studio; he became an associate of the Academy of Design in 1859; an academician in 1862 and vice-president in 1874. He traveled extensively, visiting Rome (1867–68); and being again in Italy (1875–87), residing the greater part of the time in Florence. His works include 'Elaine' (a bust); 'Morning Glory' (a medallion), and portrait of Gen. John A. Dix; statues of Napoleon (Metropolitan Museum, New York 1867); Abraham Pierson (Yale 1874) and of Winfield Scott (Washington, D. C.); portrait busts of William C. Bryant, Edwin Booth as Hamlet, Charles L. Elliott, etc.

THOMPSON, Mortimer M., American journalist and humorist: b. Riga, N. Y., 2 Sept. 1832; d. New York, 25 June 1875. He was educated at the University of Michigan, was for a time connected with the stage, settled in New York in 1852 and shortly after began writing there for the press. He subsequently became a popular lecturer and continued humorous contributions to the weekly newspapers. His books, written under the pseudonym of "Q. K. Philander Doesticks, P.B." ("Queer Kritter, Philander Doesticks, Perfect Brick"), include 'Doesticks — What he Says' (1855); 'Plu-ri-bus-tah' (1856), a travesty of Longfellow's 'Hiawatha'; 'Nothing to Say' (1857), and others.

THOMPSON, Richard Wigginton, American lawyer: b. Culpeper County, Va., 9 June 1809; d. Terre Haute, Ind., 9 Feb. 1900. He was admitted to the bar of Lawrence County, Ind.., in 1834. He served in both houses of the State legislature, and in 1840 was elected to Congress. He declined an appointment as Minister to Austria in 1849, and later the post of solicitor-general of the Land Office, which President Fillmore offered him. In 1867 he became judge of the Fifth Indiana Circuit Court, and in 1877–81 was Secretary of the Navy. He resigned this post before the completion of his term in order to become chairman of the American committee of the Panama Canal Company. He published 'The Papacy and the Civil Power' (1877); 'History of the Protective Tariff' (1888); 'Footprints of the Jesuits' (1894) and 'Recollections of Sixteen Presidents, from Washington to Lincoln' (1894).

THOMPSON, Robert Ellis, American educator: b. near Lurgan, Ireland, 5 April 1844. He was graduated at the University of Pennsylvania in 1865 and from 1868 to 1892 held successively in that institution professorships in Latin and mathematics, social science, history and English literature. He has held lectureships at Harvard, Yale and Princeton Theological Seminary, and has contributed editorially to the *Penn Monthly*, the *American*, the *Irish World* and the *Sunday School Times*. In 1874 he was ordained to the Presbyterian ministry. Since 1894 he has been principal of the Central High School of Philadelphia. His publications include 'Social Science and National Economy' (1875); 'De Civitate Dei'; 'The Divine Order of Human Society' (1891), being his Stone lectures at Princeton; 'History of the Presbyterian Churches of America' (1895); 'Protection to Home Industry' (1885), being his Harvard lectures; 'The Hand of God in American History' (1902); 'The Historic Episcopate' (1910) and 'The History of the Dwelling House and its Future' (1914). He has edited Duffield's 'Latin Hymn-writers and Their Hymns' (1889); 'Political Economy for High Schools' (1895); 'The Apostles as Everyday Men' (1912).

THOMPSON, Silvanus Phillips, English physicist: b. York, 19 June 1851; d. 1916. He was educated at Bootham School, York, at Flounders' Institute, Pontefract, and at the Royal School of Mines. In 1876–85 he held the professorship of experimental physics at University College, Bristol, and in 1885 became principal and professor of physics in the City and Guilds Technical College, Finsbury. He was president of the Physical Society; of the Institution of Electrical Engineers and of the Röntgen Society. His works include 'Elementary Lessons in Electricity and Magnetism' (1881; rev. ed., 1915); 'Dynamo-Electric Machinery' (1886; 7th ed., 1904); 'Light, Visible and Invisible' (1897; 2d ed., 1910); 'Michael Faraday' (1898); 'The Life of Lord Kelvin' (1910).

THOMPSON, Smith, American jurist: b. Stanford, N. Y., 17 Jan. 1768; d. Poughkeepsie, N. Y., 13 Dec. 1843. He was graduated at Princeton in 1788, admitted to the bar in 1792 and several years later established a law practice in New York. He was chosen to the legislature in 1800, was associate justice of the State Supreme Court in 1802–14, chief justice in 1814–18. In 1818 he became Secretary of the Navy under President Monroe, and from 1823 until his death was a justice of the Supreme Court of the United States.

THOMPSON, Vance, American journalist and playwright: b. 17 April 1863. He was graduated at Princeton in 1883, studied in Germany and was a dramatic critic in New York in 1890–97 His dramas include ‘In Old Japan,’ ‘The Dresden Shepherdess,’ ‘Florian's Dream,’ etc.; and among his books are ‘French Portraits: Being Appreciations of the Writers of Young France’ (1900); ‘Diplomatic Mysteries’ (1905); ‘The Spinners of Life’; ‘Life and Letters of Ethelbert Nevin’ (1913); ‘The Night Watchman and Other Poems’ (1914); ‘The Ego Book’ (1914); ‘Eat and Grow Thin’ (1914); ‘Drink and be Sober’ (1915); ‘The Carnival of Destiny’ (1916); ‘The Peace Girl’ (a romantic comedy drama) (1916); ‘Woman’ (1917).

THOMPSON, Waddy, American lawyer: b. Pickensville, S. C., 8 Sept. 1798; d. Tallahassee, Fla., 23 Nov. 1868. He was graduated at the South Carolina College in 1814, admitted to the bar in 1819 and in 1826–30 served in the State legislature. He became solicitor of the Western Circuit in 1830, was elected brigadier-general of militia at the time of the Nullification excitement and in 1835–41 was a Whig member of Congress. In 1840 he was chairman of the Committee on Military Affairs. He was appointed Minister to Mexico in 1842, and while on this mission concluded two important treaties and procured the liberation of more than 200 Texan prisoners. He published ‘Recollections of Mexico’ (1846).

THOMPSON, William, American Revolutionary soldier: b. Ireland, about 1725; d. near Carlisle, Pa., 4 Sept. 1781. He served as captain of militia in the French and Indian War (1759–60) and was made colonel of eight Pennsylvania companies in June 1775. The following year he took the same rank in the Continental Army and later became brigadier-general. He relieved Gen. Charles Lee at New York and in April led 14 regiments to Canada to re-enforce General Thomas, during whose illness he commanded until General Sullivan arrived. By the latter's orders he led an unsuccessful attack on the British at Trois Rivières on 6 June and was captured but immediately paroled.

THOMPSON, William Hale, American mayor: b. Boston, Mass., 14 May 1869. In infancy he was removed by his parents to Chicago, where he was educated in the public schools. He spent five seasons on the ranches of the Standard Cattle Company in Colorado, Montana and Wyoming; was for three years manager of a cattle ranch in Nebraska. Since his father's death Mr. Thompson has managed the real estate interests left by his father and other real estate interests of his own. In 1900–02 he served as alderman from the second ward of Chicago; in 1902–04 was county commissioner of Cook County and in 1915–19 was mayor of Chicago.

THOMPSON, William Howard, American lawyer and legislator: b. Crawfordsville, Ind., 14 Oct. 1871. The family moved to Kansas while he was a child and he was educated at the Seneca Normal School. He studied law with his father and was admitted to the Kansas bar in 1894. He was clerk of the Court of Appeals (1906–13) and was elected United States senator in 1913. In 1916 he served as delegate to the Democratic National Convention.

THOMPSON, William Tappan, American newspaperman and humorist: b. Ravenna, Ohio, 31 Aug. 1812; d. Savannah, Ga., 24 March 1882. He lived for a time in Philadelphia where he worked on the *Chronicle*; afterward was secretary to James D. Westcott while Territorial governor of Florida, and studied law under his charge. He became assistant editor of *The State Rights Sentinel*, was a volunteer in the Seminole War (1835–36), and established *The Mirror* in Augusta, Ga., afterward merged with *The Family Companion*. Thereafter he was attached to several papers and won reputation as a humorist by the «Major Jones Letters» written for *The Miscellany* which he established in Madison. He was associated with Park Benjamin in publishing at Baltimore; served on the staff of Governor Brown in the Civil War, and also as a Confederate volunteer. In 1887 he sat in the Constitutional Convention of his State. His many publications were popular and were collected and issued by his daughter after his death. He wrote several successful plays, including a dramatization of the ‘Vicar of Wakefield.’

THOMPSON, Wordsworth, American artist: b. Baltimore, Md., 27 May 1840; d. Summit, N. J., 28 Aug. 1896. He began to sketch soldiers and battle scenes in 1861, and his work proved popular with the newspapers. He went to Paris and studied in the École des Beaux Arts, and exhibited ‘The Morelands of Au-Fargi’ in the Salon of 1865. In 1868 he settled in New York, but made several trips abroad at later intervals. His painting, ‘Desolation’ (1875), won him an associate membership in the National Academy. In 1877 he became a full-fledged academician; in 1878 he was made a member of the Society of American Artists; in 1879 he won a gold medal at the Paris Exposition. Among his noted paintings are ‘Annapolis in 1776’ (owned by the Buffalo Fine Arts Academy); ‘Passing the Outpost’ (owned by the Union League Club, New York); ‘The Parting Guest’ (owned by the New York Historical Society); ‘A Midsummer Day on Long Island’; ‘A May Day on Fifth Avenue,’ etc.

THOMPSON, Conn., town in Windham County, on the French and Quinebaug rivers, and on the New York, New Haven and Hartford Railroad. Within the town limits are the villages of Grosvenor Dale, North Grosvenor Dale, New Boston, Thompson, East Thompson, West Thompson, Wilsonville, Mechanicsville and Quinebaug. It is in an agricultural region. The chief manufacturing establishments are cotton and woolen mills, flour and grist mill, planing mills, a boot and shoe factory and machine shops. Thompson was originally a part of Killingly, but became a parish in 1728, and in 1785 was incorporated as a town. Pop. 4,804.

THOMPSON INDIANS. See SALISHAN.

THOMPSON'S STATION, Battle of. After the battle of Stone River (q.v.) the Confederate cavalry were active on Rosecrans' flanks and rear, and late in February 1863 Gen. Earl Van Dorn, with over 6,000 men, crossed the Tennessee River at Florence and marched northward to Columbia, on Duck River, threatening Franklin, about 28 miles nearly west of Murfreesboro. On 4 March General Rosecrans ordered a general reconnoissance in front of his lines to ascertain the Confederate strength and, if possible, the enemy's intention. One of these reconnoitering columns was sent from Franklin. It was under command of Col. John Coburn and consisted of his brigade — 33d and 85th Indiana, 19th Michigan and 22d Wisconsin — the 124th Ohio, 600 cavalry under Col. T. J. Jordan and Aleshire's Ohio battery of six guns; in all 2,837 officers and men. A train of 101 wagons accompanied the expedition, 80 of which were to collect forage. Coburn was instructed to advance the first day to Spring Hill, where he was to halt for the night of the 4th, and next day divide his force, sending part of it to Rally Hill, on the left, to meet a co-operating cavalry column from Murfreesboro, and the other part toward Columbia, each to return to Spring Hill at night, unless the detachment at Rally Hill should be joined by the cavalry expected from Murfreesboro. Colonel Jordan, with the cavalry and battery, led the advance and when three miles out of Franklin met Gen. W. H. Jackson's cavalry division of two brigades and King's battery moving north. Both parties formed for battle, Aleshire opened with his guns, King's guns replied, the skirmishers became engaged, and after a brisk engagement of an hour Jackson withdrew toward Spring Hill and Coburn went into camp four miles south of Franklin. One of Aleshire's guns had been disabled and with the forage train of 80 wagons, half of them loaded, was sent back to Franklin. Van Dorn had started from Columbia that morning with the five brigades of Gens. N. B. Forrest, W. T. Martin, G. B. Cosby, F. C. Armstrong and Col. J. W. Whitfield, 6,000 men and 12 guns, and when Jackson with the two brigades of Armstrong and Whitfield fell back after the engagement, Van Dorn formed line at Thompson's Station, nine miles south of Franklin, and awaited Coburn's advance. Jackson's division was posted on a range of hills crossing the Franklin pike, with King's battery on the extreme left and Forrest's brigade, with a battery, was on Jackson's right. On the morning of the 5th Coburn advanced cautiously and on nearing Thompson's Station Jordan charged with his cavalry, drove a small Confederate force from the station and seized a range of hills near it. Coburn followed with the infantry to near the station, when, on entering a pass, with hills on either side, he was arrested by shells from the Confederate artillery on his right and left, enfilading his line. It was necessary to dislodge King's battery on his right and he formed his line for the attack; Aleshire's guns on opposite sides of the turnpike and railroad which ran close to each other, the guns supported by the cavalry, and the 33d and 85th Indiana advanced down the hill against King's battery, when suddenly the Confederate guns ceased firing and from behind a stone wall Whitfield's brigade, reinforced by a regiment of Armstrong's, opened a fire that drove the two regiments back up the hill. Whitfield followed, and when nearing the summit he was charged and driven back, made a stand behind the depot of Thompson's Station and with the assistance of two of King's guns compelled Coburn's men to fall back beyond the hill. At about the same time Coburn was informed that about 1,000 cavalry had been discovered on the left and he resolved to retreat; but it was first necessary to check the Confederate advance. The movement in retreat was to be covered by the battery and the cavalry, but when Jordan saw the signs of a movement in retreat and the probability of being cut off by Forrest's cavalry on the left, he ordered the wagon train and its guard to the rear, to be followed by the battery, Jordan following the battery after a slight resistance to Forrest. Meanwhile Armstrong and Whitfield had been ordered to assault Coburn's left and Forrest to reach his rear. Armstrong, Whitfield and part of Forrest charged, and after a fierce struggle for the crest of the hill were again driven from it with great loss. Again the Confederates charged; Coburn was forced back; Forrest, with two regiments, gaining his rear, charged him; and after a few volleys at close quarters Coburn surrendered. His loss, as officially reported, was 48 killed, 247 wounded and 1,151 captured or missing. Van Dorn's loss was 56 killed, 289 wounded and 12 missing. Meanwhile other columns had pushed out from Murfreesboro and driven other bodies of Confederate cavalry across Duck River and Gen. Gordon Granger, commanding the reserve corps of Rosecrans' army, upon hearing of Coburn's defeat, strengthened Franklin and concentrated a column at that place to move upon Van Dorn, at Spring Hill and Thompson's Station. Granger moved on the 9th, attacked and drove Armstrong's cavalry brigade from Thompson's Station and advanced to Spring Hill, Van Dorn having fallen back during the day to recross Duck River at Columbia. On the next day Granger's cavalry pushed Armstrong across Rutherford's Creek near Columbia; and Van Dorn's main body recrossed Duck River. Pursuit was suspended and on the 11th the various commands engaged in the general reconnoissance returned to their former positions. Consult 'Official Records' (Vol. XXIII); Van Horne, 'History of the Army of the Cumberland' (Vol. I); Wyeth, 'Life of Gen. N. B. Forrest.'

E. A. CARMAN.

THOMSON, tŏm'sŏn, Charles, American patriot: b. Maghera, County Derry, Ireland, 29 Nov. 1729; d. Lower Merion, Pa., 16 Aug. 1824. He came to America in 1740, was educated in the academy at Thunder Hill, Md., and became a teacher in the Friends' Academy, Newcastle, Del., afterward taught in Philadelphia, and then engaged in business in that city. He acted as commissioner among the Indians and in 1756 was adopted into the Delaware tribe as the «Truth Teller.» From the first he ardently espoused the cause of the colonies, and in 1774 was made secretary of the Continental Congress, a post he occupied until 1789. Upon Washington's election to the Presidency he was sent to Mount Vernon to inform him of the event. He then retired from public life and afterward occupied himself with literary labors.

He published 'An Enquiry into the Causes of the Alienation of the Delaware and Shawanese Indians' (1759); 'The Holy Bible, containing the Old and New Covenant, translated from the Greek [the Old Covenant from the Septuagint]' (1808), and 'A Synopsis of the Four Evangelists' (1815). Consult Harley, 'The Life of Charles Thomson' (1900).

THOMSON, Sir Charles Wyville, Scottish naturalist: b. Bonsyde, Linlithgow, 5 March 1830; d. there, 10 March 1882. He was educated at the University of Edinburgh, where he took the medical course and showed great ability in botany and natural history. He was appointed lecturer on botany in King's College, Aberdeen, in 1850 and professor at Marischal College in 1851. He filled the chair of natural history in Queen's College, Cork, in 1853 and in 1854 went to Queen's College, Belfast, as professor of mineralogy and geology. In 1860 he was transferred to the chair of natural science in the same college and in 1868 became in addition professor of botany in the Royal College of Science at Dublin. He returned to Scotland in 1870 to become professor of natural history in the University of Edinburgh. He took an active part in the scientific investigation of the British seas by the *Lightning* and *Porcupine* expeditions and published 'The Depth of the Sea' (1873). He was appointed in 1872 chief of the scientific staff of the *Challenger* Expedition (q.v.), and on its return in 1876 was knighted. In 'The Voyage of the Challenger: the Atlantic' (1877) he gave a general account of part of the investigations carried out on the famous voyage.

THOMSON, Edward, American Methodist Episcopal bishop: b. Portsea, England, 12 Oct. 1810; d. Wheeling, W. Va., 22 March 1870. He came to the United States in 1819, was graduated in medicine at the University of Pennsylvania in 1829 and practised in Jeromeville and Wooster, Ohio. In 1832 he united with the Methodist Church and in the following year was admitted into the Ohio Conference. He was pastor of a church in Detroit, Mich., in 1836 and in 1838–43 was principal of the Norwalk Seminary. He was the first president of the Ohio Wesleyan University at Delaware, in 1846–60, and in 1864 he was elected bishop, in which office he continued until his death. He edited the *Ladies' Repository* at Cincinnati 1844–46, the *Christian Advocate and Journal*, New York 1860–64, made a missionary tour of the world and published 'Moral and Religious Essays' (1856); 'Sketches, Biographical and Incidental' (1856); 'Our Oriental Missions' (1870); 'Evidences of Revealed Religion' (1872), and other works.

THOMSON, Edward William, American civil engineer and author: b. Toronto, Ont., 12 Feb. 1849. He was educated in Trinity College Grammar School and by his own exertions. When but 16 he enlisted and served (1864–65) in the Third and Fourth Pennsylvania regiments; and in the Queen's Own Rifles in 1866. He became a political writer on the *Toronto Globe* (1879–91); was editor of the *Youth's Companion*, Boston (1891–1901), afterward becoming a special writer on Canadian politics. He was also the traveling correspondent of the *Evening Transcript*, Boston. His published works include 'Old Man Savarin' (1895), 'Between Earth and Sky' (1897), 'Aucassin and Nicolette' (1895, versified from the translation); 'When Lincoln Died, and other poems' (1909), etc.

THOMSON, Elihu, American inventor and electrician: b. Manchester, England, 29 March 1853. In 1858 he came to the United States, was educated in the public schools in Philadelphia and from 1870 to 1880 was professor of chemistry and mechanics in the Central High School there. After a visit to the Paris Exposition in 1878 he became interested in the subject of lighting by electricity and his experiments, carried on with the aid of E. J. Houston, resulted in patents secured in 1878 and 1879. The following year he became electrician to the American Electric Company, afterward known as the Thomson-Houston Electric Company. This, by consolidation with the Edison Company in 1892, became the General Electric Company, the largest plant for producing electrical machinery in the world. His patented inventions in electrical appliances number over 600 and many of them have come into universal use. Among these are the three-coil armature for dynamos and motors; the induction-coil system of distribution; the induction motor; the constant-current regulator for arc-lighting dynamos; the process of welding metals by electricity; the magnetic blow-out for switches and fuses and the electric meter for direct and alternating currents. Since 1892, when the General Electric Company established its plant in Lynn, Mass., he has resided there, retaining his connection as consulting electrical engineer. In 1889 he became president of the American Institute of Electrical Engineers, and in 1890 received from the Paris commission half the prize of 10,000 francs for his meter. He was decorated in 1889 for electrical inventions by the French government as Officer et Chavalier de la legion d'Honneur; given the honorary degrees of A.M., Yale, D.Sc., Harvard and Ph.D., Tufts; has received many medals and awards, among which is the Rumford Medal, and was awarded Grand Prix at Paris expositions of 1889 and 1900. He is past president of the American Institute of Electrical Engineers, Fellow of American Academy of Arts and Sciences, member of the Institution of Civil Engineers, London, the American Chemical Society, the American Physical Society, the National Academy of Sciences and of many other societies, and was official United States delegate to Chamber of Delegates, Electrical Congress, in 1893 at Chicago. He has been for many years a Fellow of the American Association for the Advancement of Science, serving as vice-president at the Columbus meeting, Section B, Physics; and has been vice-president of the American Physical Society. He was president of the International Electrical Congress at Saint Louis in 1904 and also president of the Chamber of Official Delegates at the said Congress. He was elected honorary member of the Institution of Electrical Engineers of Great Britain in 1904. In 1909 he was elected president of the International Electrotechnical Commission, succeeding the late Lord Kelvin in that capacity upon the decease of the latter. Professor Thomson was the first recipient of the Edison medal and also received the award of the Eliott Cresson gold medal by the Franklin Institute, Philadelphia, for his electrical work. Among the most notable of his papers prepared for scientific societies are that on 'Electric Welding,' read before the Boston Society of Arts in 1886, and one prepared for the American Institute of Electrical Engineers in 1887, on 'Novel Phenomena of Alternating Currents.'

THOMSON, Frank, American engineer and railroad president: b. Chambersburg, Pa., 5 July 1841; d. Merion, Pa., 5 June 1899. As a student he acquired a thorough practical and scientific knowledge of mechanical engineering, so that when he quit the shops of the Pennsylvania Railroad at Altoona, he was able to build a locomotive. As chief assistant to the Assistant Secretary of War he constructed roads and bridges and superintended the transportation of troops during the Civil War; after which he was appointed superintendent of the eastern division of the Philadelphia and Erie Railroad. He re-entered the service of the Pennsylvania Railroad in 1873 and as superintendent of the eastern system constructed the excellent road-bed and introduced the standard track. From 1897 until his death he was president of the company.

THOMSON, George, Scottish song collector: b. Limekilns, Scotland, 4 March 1757; d. Leith, Scotland, 18 Feb. 1851. He was educated at Banff and in 1780 removed to Edinburgh where he became junior clerk to the board of trustees for the Encouragement of Arts and Manufactures. He was subsequently promoted to be chief clerk, an office he held until his retirement in 1839. In 1792 he conceived the plan of making a complete collection of Scottish airs, secured the services of such well-known authors as Campbell, Scott and Burns to supply words for the melodies where necessary and since there was neither prelude nor coda to the songs he engaged Pleyel, Haydn, Beethoven, Mozart and others of note to remedy the deficiency and also to compose accompaniments for them. The results of his labors were published as follows: Scottish airs (6 vols., 1793–1841); Welsh (3 vols., 1809–14), and Irish (2 vols., 1814–16).

THOMSON, James, Scottish poet: b. Ednam, Roxburghshire, 11 Sept. 1700; d. Richmond, Surrey, 27 Aug. 1748. He was educated at the University of Edinburgh in 1715 and at first intended to enter the ministry, but in 1725 went to London to devote himself to literature. His poem on 'Winter' was published in the following year, in 1727 it was followed by 'Summer,' 'Spring' appeared in 1728 and in 1730 the series was completed and published as 'The Seasons.' It was very successful and was followed by his play 'Sophonisba,' produced at Drury Lane in 1730. For two years he was on the Continent as traveling tutor to the son of Charles Talbot, afterward Lord Chancellor, and on the death of his pupil in 1733 was appointed by the young man's father to a sinecure office with a salary of £300 a year. He published a patriotic poem entitled 'Liberty' (1734–36), included in 1736 in the volume with 'Sophonisba' and 'Britannia.' His famous song, 'Rule Britannia,' formed part of 'The Masque of Alfred' (1740), written by him with his friend, David Mallet, to music composed by Dr. Arne. In 1744 Lord Lyttelton conferred upon him the sinecure office of surveyor-general of the Leeward Islands, worth £300 a year. In the same year he issued a new edition of 'The Seasons' with extensive additions and alterations, and in 1748 appeared 'The Castle of Indolence: An Allegorical Poem,' a fine imitation of Spenser. He was buried in the parish church of Richmond. Among his works not already mentioned are 'Agamemnon' (1738), a play; 'Edward and Eleanora' (1739), a play which was published but rejected by the censor; 'Tancred and Sigismunda,' a tragedy (1745), his most successful play, and 'Coriolanus' (1749), a posthumously acted play. 'The Seasons' marks the dawn of a new era in English poetry, an era characterized by a departure from the formation and artificiality of Pope and his school in favor of simplicity and truthfulness to nature. The impulse gathered strength in Gray and Cowper, and reached its fullest expression in Wordsworth. The work found warm admirers in France and other countries and is still read. A good recent edition of Thomson's works is the 'Aldine' (1897) by Tovey. (See SEASONS, THE). Consult Morel, L., 'James Thomson, sa Vie et ses Œuvres' (Paris 1895); 'Life' in Tovey's edition; Bayne, 'Thomson' ('Famous Scots Series,' 1898); Macaulay, G. C., 'James Thomson' (New York 1908).

THOMSON, James, British professor of engineering: b. Belfast, 16 Feb. 1822; d. Glasgow, 8 May 1892. He was a brother of William Thomson, Lord Kelvin, and was graduated from the University of Glasgow in 1839. In 1851 he settled at Belfast as civil engineer and in 1857 became Crown professor of civil engineering at Queen's College. Here he remained unil 1873, when he was called to the similar chair at Glasgow. In early life he was devoted to various inventive purposes, his first being a mechanism for feathering the floats of steamer paddles. More practical was his invention in 1850 of a «vortex water-wheel,» and later of a jet-pump used in draining lowlands, a centrifugal pump and improvements in turbines and in the action of blowing-fans. For many years he was engaged in investigations of the plasticity of ice, his first contribution to the subject (1848) being a paper communicated to the Royal Society of Edinburgh on 'The Effect of Pressure in Lowering the Freezing-point of Water.' The most important of his contributions to this subject dealt with «crystallization and liquefaction as influenced by stresses tending to change of form in crystals.» He also published researches on currents of atmospheric circulation; on the flow of water in rivers and on the jointed prismatic structure seen at the Giants' Causeway. Failure of eyesight caused him to resign his chair in 1889.

THOMSON, James, Scottish poet: b. Port-Glasgow, 23 Nov. 1834; d. London, 3 June 1882. He was trained at Chelsea for the calling of army schoolmaster and after teaching at various regimental centres was discharged from the army with several others for a breach of discipline in 1862. He had gained the friendship of Charles Bradlaugh (q.v.) and contributed to his *National Reformer* over the signature B. V. In 1872 he was in Colorado as agent of a mining company and in the following year went to Spain as a war correspondent for the New York *World*. In 1874 (March to May) he contributed to the *National Reformer* his most famous poem, 'The City of Dreadful Night' (printed in book form, with other poems, 1880), a finished, sombre work, in which his gloomy temperament clearly shows itself. His other publications include 'Vane's Story, Weddah and Om-el-Bonain and other Poems' (1881); 'Essays and Phantasies' (1881); 'A Voice from the Nile and other Poems' (1884); 'Satires and Profanities' (1884), and 'Poems, Essays and Fragments' (1892). His 'Poetical Works' were issued in two volumes in 1895 and a volume of 'Biographical and Critical Studies' appeared in 1896. (See CITY OF DREADFUL NIGHT, THE). Consult the 'Life' by Salt (1889; rev. ed., 1898); also Ward, 'English Poets' (2d ed., Vol. IV, 1883).

THOMSON, John, Scottish painter: b. Dailly, Ayrshire, 1 Sept. 1778; d. Duddingston, 30 Oct. 1840. He studied for the ministry in Glasgow University for a year, in 1793 entered the University of Edinburgh and on his father's death in 1799 succeeded him as minister of his native parish. In 1805 he was presented to the parish of Duddingston, near Edinburgh, and here he rapidly acquired fame as a landscape-painter and developed a close friendship with Sir Walter Scott. His pictures were much in demand and he exhibited frequently in Edinburgh. On the foundation of the Scottish Academy in 1830 he was elected an honorary member, after declining ordinary membership. Many of his pictures are in the National Gallery of Scotland, but a considerable number are hung in private collections. Among the former are 'Bruce's Castle of Turnberry'; 'Ravensheugh Castle'; 'Scene on the Clyde'; 'The Trossachs'; 'Aberlady Bay,' and 'Trees on the Bank of a Stream.' The National Gallery in London contains 'Loch an Eilan' and the South Kensington Museum has a water-color of 'Duddingston Loch.' He felt throughout his artistic life the want of early and systematic training, but he holds a distinct place in the history and development of British art, as the first painter to grasp and express the wildness and power of Scottish scenery. Consult Baird, 'John Thomson' (1895).

THOMSON, Joseph, Scottish explorer in Africa: b. Penpont, Dumfriesshire, 14 Feb. 1858; d. London, 3 Aug. 1895. He was educated at the University of Edinburgh and there distinguished himself so highly that he was appointed in 1878 geologist and naturalist to the exploring expedition sent out to East Central Africa by the Royal Geographical Society under the command of Alexander Keith Johnston. When Johnston died, 28 June 1879, Thomson assumed the leadership of the party and conducted it to Lake Tanganyika and near the head-waters of the Kongo. A mutiny of his followers prevented him from proceeding farther and he returned by way of Lake Leopold, reaching the coast 10 July 1880. In 1882 he set out on a great journey from the east coast of Africa to Victoria Nyanza. This was undertaken on behalf of the Royal Geographical Society and during it he visited Kilimanjaro and Mount Kenia and proceeded through the country of the Masai by way of Lakes Naivasha and Baringo to Victoria Nyanza. In 1885 he was awarded the founder's medal of the Royal Geographical Society and in the same year traveled in Nigeria on behalf of the National Africa Company in order to conclude treaties with the kings of Sokoto and Gando. In 1888 he explored the Atlas Mountains in Morocco and in 1890–91 traveled on behalf of the British South Africa Company in the territory of the Central Africa Protectorate. His travels are described in his works 'To the Central African Lakes and Back: the narrative of the Royal Geographical Society's East Central African Expedition, 1878–80' (1881); 'Through Masai Land: a Journey of Exploration Among the Snowclad Volcanic Mountains and Strange Tribes of Eastern Equatorial Africa' (1885); 'Travels in the Atlas and Southern Morocco: a Narrative of Exploration' (1889). He also wrote a work on 'Mungo Park and the Niger' (1890) and a novel 'Ulu,' with Miss Harris-Smith. Consult 'Life' by J. B. Thomson (1896).

THOMSON, SIR Joseph John, English physicist: b. Manchester, 18 Dec. 1856. He was educated at Owens College, Manchester, and at Trinity College, Cambridge; was lecturer at Trinity in 1883 and since 1884 has been professor of experimental physics at Cambridge. His researches and lectures tend far toward establishing the theory of ions. He has also been an active member of the Society for Psychical Research. He has published 'A Treatise on the 'Motion of Vortex Rings' (1884); 'Recent Researches in Electricity and Magnetism' (1892); 'Elements of the Mathematical Theory of Electricity and Magnetism' (1895); 'Conduction of Electricity through Gases' (1903); 'Corpuscular Theory of Matter' (1907); 'Thermochemistry' (1915), etc. In 1906 he received the Nobel prize in physics and in 1908 he was knighted.

THOMSON, Thomas, Scottish antiquary, elder brother of Rev. John Thomas, the painter: b. Dailly, Ayrshire, 10 Nov. 1768; d. Edinburgh, 2 Oct. 1852. He was graduated from Glasgow University in 1789 and adopting law as his profession, went to Edinburgh and was admitted an advocate in 1793. He acquired a large practice, but gradually devoted himself more and more to the study of legal antiquities. In 1832 he succeeded Sir Walter Scott, who was one of his close friends, as president of the Bannatyne Club. Among his numerous publications are 'The Acts of the Parliament of Scotland, 1424–1707' (10 vols., 1814–24); 'Registrum Magni Sigilli Regum Scotorum, 1306–1424' (1814); 'The Acts of the Lords Auditors of Causes and Complaints, 1466–94' (1839), and 'Acts of the Lords of Council in Civil Causes, 1478–95' (1839); 'Forms of Process in the Court of Session during the Earlier Periods, with the later variations' (1839); 'Chamberlain Rolls' (3 vols., 1817 and 1845); 'Memoirs of Sir George Mackenzie' (1821). Consult 'Memoir' (1854) by Cosmo Innes.

THOMSON, Thomas, British chemist: b. Crieff, 12 April 1773; d. near Holy Loch, 2 July 1852. He was educated at Crieff, Stirling and the University of Saint Andrews, and in 1799 graduated M.D. at Edinburgh. He edited the supplement to the third edition of the 'Encyclopædia Britannica,' to which he contributed the articles 'Chemistry,' 'Mineralogy' and ‹Vegetable, Animal and Dyeing Substances.› In the article ‹Mineralogy› he used the system of symbolic representation, but it is incorrect to describe him as the introducer of this auxiliary of chemical science. In 1800 on the completion of the ‹Encyclopædia,› he began a course of lectures on chemistry, which he continued till 1811, opening, in addition, a laboratory for practical instruction in chemistry, about the first institution of the kind in Great Britain. In 1802 he published the first edition of his ‹System of Chemistry,› which obtained rapid success both in Great Britain and on the Continent. In 1810 he published his ‹Elements of Chemistry.› His ‹History of the Royal Society› appeared in 1812. In 1813 he went to London and began there a scientific journal, the *Annals of Philosophy,* which he continued to edit till the end of 1820. The lectureship in chemistry in the University of Glasgow was conferred on him in 1817, the office being shortly afterward raised to a professorship, and he himself created regius professor of chemistry in 1818. His work on the atomic theory was published in two volumes in 1825, under the title of ‹Attempt to Establish the First Principles of Chemistry by Experiment.› The accuracy of the work was severely criticized by the Swedish chemist Berzelius. Thomson discovered a large number of chemical compounds, such as hyposulphurous acid, chlorochromic acid and a great variety of salts. In 1830–31 he published his ‹History of Chemistry,› and in 1836 appeared his ‹Outlines of Mineralogy and Geology.› In 1846 he retired from his professional duties.

THOMSON, William, English archbishop: b. Whitehaven, 11 Feb. 1819; d. York, 25 Dec. 1890. He was educated at Queen's College, Oxford, of which he was successively Fellow, tutor and head. Ordained deacon in 1842, he was curate at Saint Nicholas, Guildford and Cuddesdon, near Oxford, 1842–47, when he was made tutor of his college, of which he became provost in 1855. In 1861 he edited a series of essays by various writers under the title ‹Aids to Faith,› intended as a counterblast to ‹Essays and Reviews›; and in that year was appointed bishop of Gloucester and Bristol. In February 1863 he became archbishop of York. He was the author of ‹An Outline of the Necessary Laws of Thought› (1842); ‹The Atoning Work of Christ, viewed in Relation to some Current Theories› (1853); ‹Crime and its Excuses› (in Oxford Essays, 1855); ‹Life in the Light of God's Word›; ‹Limits of Philosophical Inquiry›; ‹Design in Nature›; and a series of essays entitled ‹Word, Work and Will.›

THOMSON, William, 1st Lord Kelvin, British mathematician and physicist: b. Belfast, 26 June 1824; d. Glasgow, Scotland, 17 Dec. 1907. He was graduated from Cambridge in 1845, and in 1841 published a paper ‹On the Uniform Motion of Heat in Homogeneous Solid Bodies, and in Connection with the Mathematical Theory of Electricity,› contributed to the *Cambridge Mathematical Journal.* In 1845 he became first editor of the *Cambridge and Dublin Mathematical Journal,* a post which he held for seven years. He was appointed professor of natural philosophy in the University of Glasgow in 1846, and occupied this position for 53 years, till his resignation in 1899. His jubilee as a professor was celebrated in 1896 by many brilliant university functions and distinguished men of science came from many countries to do him honor. Lord Kelvin's contributions to physical science and its applications are very numerous. In all the domains of dynamics, sound, light, heat, magnetism and electricity there are achievements to his credit. The form in which the mariner's compass is now generally employed was patented by him in 1876, and the siphon recorder used in connection with almost all submarine cables was introduced by him in 1867. His extremely delicate mirror galvanometer was also originally invented for the purposes of submarine telegraphy, and in this connection his automatic curb sender is also worthy of notice. His quadrant and absolute electrometers are well known to the student of electrostatics, and his portable electrometer and water-dropping apparatus are of great use in practical meteorology. He published important papers on the theory of magnetism, and the theory of electric images with the associated method of electric inversions is due to him. Lord Kelvin was the first to direct the attention of scientific men to Sadi Carnot's pioneer work in thermodynamics, and it is mainly to his researches and those of Rankine and Clausius that we owe the present advanced condition of that science. The absolute scale of temperature based on the second law of thermodynamics was first proposed by Lord Kelvin. In the building up of the great modern doctrine of the conservation of energy Lord Kelvin took an important part, and the portion of that doctrine known as the dissipation of energy is almost entirely due to him. He also propounded a modified atomic theory in which the atoms are conceived as vortices, and he threw much light on such questions as the age of the earth, cosmic evolutions and geological time. Lord Kelvin, then William Thomson, was associated as electrician with the company which undertook the laying of an Atlantic cable in 1857, and was largely responsible for the success which ultimately crowned this pioneer effort of submarine telegraphy in 1866. He might, indeed, be called the first electrical engineer. He was knighted in 1866, and in 1892 was raised to the peerage as Baron Kelvin of Netherall, Largs, Ayrshire. He was president of the Royal Society from 1890 to 1895, and was awarded the Copley and Royal medals. In 1871 he presided over the meetings of the British Association at Edinburgh. He was Rede lecturer at Cambridge in 1866 and was many times elected president of the Royal Society of Edinburgh. He was awarded the Prix Poncelet by the Institute of France in 1874, and the Helmholtz medal by Germany in 1892. He received so many honors that there is not space to enumerate them. Perhaps the most notable was the jubilee celebration of his professorship at Glasgow University in 1896. The gathering was attended by 2,500 distinguished guests; the ceremonies and jubilation lasted three days. The Grand Cross of the Royal Victorian Order was conferred on him. The city officials joined in the event, cable companies all over the world sent congratulations and a message was sent from the university half around the world, via Newfoundland, New York, San Francisco, New Orleans, Washington and back to London and Glasgow, being received by Lord Kevlin in seven and one-half minutes. Lord Kelvin's most important published work is the well-known 'Treatise on Natural Philosophy' (Part I, 1867; new ed., 1879), written with Professor Tait. An abridged edition has also been published. His other works are 'Papers on Electrostatics and Magnetism' (1873); 'Mathematical and Physical Papers' (1882, 1884, 1890); 'Popular Lectures and Addresses,' and articles in the 9th edition of the 'Encyclopædia Britannica,' some of which have been also published separately. He visited the United States in 1884, in 1892 and again in 1902. Consult his 'Life' by Andrew Gray (1908), and by Thompson, S. P., (1910).

THOMSONITE, one of the zeolite family of minerals ($H_{10}(Na_2,Ca)_5Al_{10}Si_{10}O_{40}$). It usually occurs in columnar forms or radiated concretions of snow-white color; less frequently in distinct orthorhombic crystals (comptonite). It is a hydrous silicate of aluminum, sodium and calcium. It is found filling cavities in igneous rocks in Scotland, the Faroe Islands, Nova Scotia, at Golden in Colorado, and elsewhere. Much so-called thomsonite, including the pebbles of Grand Marais, Minnesota, is mesolite.

THOR, thôr or tôr, in Norse mythology, the god of thunder, son of Odin by Jörd (the earth). He was represented as a powerful man in the prime of life, with a red beard, girt with his girdle of strength, and armed with his mighty hammer Miölnir («the smasher»). He was the foe of the giant demons, and friendly to man. Some have thought him identical with Jupiter; others identify him with the Anglo-Saxon, Thonar. Sacrifices were offered up to him under oaks. Thursday has its name from him. Consult Uhland, 'Der Mythus vom Thor' (1868).

THORACIC DUCT, a vertical canal lying in front of the spine, and receiving the terminations of the lacteal and lymphatic vessels. It is the receptacle for the materials which go to renovate the blood, these materials being derived from the digestion of food and from the elaborated products of the lymphatic glands. From the thoracic duct the chyle or nutrient matter is poured directly into the current of the circulation, the duct opening into the great veins (internal jugular and subclavian veins) lying at the root of the neck on the left side. A second and smaller lymphatic or thoracic duct lies on the right side of the body, and receives the contents of the lymphatics of the right arm and right side of the head. The chief thoracic duct is dilated at its lower extremity, at the junction of the loins and back, into the receptaculum chyli. The contents of the thoracic duct contain the elements of the blood already elaborated.

THORAH, tō'ra, or **TORAH,** in Hebrew literature, a definite commandment laid down by recognized authority. When used with the definite article the word refers specifically to the Mosaic law, that is the Pentateuch; and often to the Ten Commandments.

THORAX, that part of the trunk in higher vertebrates between the neck and abdomen containing the heart, lungs and other viscera, enclosed by the ribs, sternum and thoracic vertebræ. Sometimes the term is restricted to the bony structure that forms the chest. The term is also applied to those segments of the body in *Arthropoda* which lie between the head and the abdomen. Thus in insects there are three segments forming the thorax, named, respectively, the prothorax, mesothorax and metathorax. The prothorax bears the first pair of legs, the mesothorax the second pair of legs and first pair of wings, while the metathorax bears the third pair of legs and second pair of wings. In crustaceans and spiders the head and chest segments are united together to form a single mass, named the cephalothorax. In man and higher vertebrates the thorax is formed by the sternum or breast-bone in part and by the ribs and spine, laterally and behind. In mammals alone is the thorax and its cavity completely shut off from the cavity of the abdomen by a complete diaphragm or midriff. See ANATOMY; OSTEOLOGY, HUMAN; TORSO.

THOREAU, thō'rō, **Henry David,** American «poet-naturalist»: b. Concord, Mass., 12 July 1817; d. there, 6 May 1862. He was graduated at Harvard in 1837 and began in that year the copious journal with which in 1850–60 he filled 30 manuscript volumes, did some teaching at Concord and on Staten Island, N. Y., appeared occasionally as a lyceum lecturer in Concord and other New England towns that chanced to call him, and, until his death, practised at intervals and with great skill his art of pencil-manufacture, making, Emerson said, as good an article as the best English. In 1839 he took the excursion recorded in 'A Week on the Concord and Merrimac Rivers,' which was published in 1849 in an edition of 1,000; the return of 700 as unsalable (1853) afforded him the humorous boast that he had now a fair-sized library all of his own writing. In the course of the voyage there are many phases for speculation and opinion, the result being less a narrative than a collection of essays and discussions. Chiefly for the preparation of this work, but also to undertake an experiment in simplicity of living, and to have opportunity for his observation of wild nature, he lived alone, in a house built by himself, from July 1845 to September 1847, at Walden Pond, not far from Concord village. There, too, he wrote several of his papers and gathered material for his 'Walden, or Life in the Woods' (1854), the best known and probably the most nearly classic of his books. After this episode, which some folk professed to think very odd, «he preferred,» says Emerson, «short work,» building boats, grafting, surveying and other odd jobs, writing meanwhile for current periodicals. In 1846, 1853 and 1857 he went to the Maine woods, and his accounts, partially printed in magazines in his lifetime, were posthumously collected in book form, constituting what is perhaps, after 'Walden,' his most interesting work. Other jaunts to Cape Cod (1849) and Canada (1850) were also described. The titles of these posthumous volumes are 'Excursions' (1863); 'The Maine Woods' (1864); 'Cape Cod' (1865); 'Early Spring in Massachusetts' (1881); 'Summer' (1884); 'Winter' (1888);

Henry D. Thoreau.

'Autumn' (1892); 'Miscellanies' (1894); 'The First and Last Journeys of Thoreau, lately discovered among his unpublished Journals and Manuscripts,' edited by Sanborn (Boston 1905). He refused in 1841 to pay taxes to a government concerned in slavery and war, and was jailed for a few hours. He was said to have aided the escape of fugitive slaves when at Walden. At any rate he sounded the bell to announce Emerson's first anti-slavery address at Concord, and on 30 Oct. 1859 made there a bold public defense of John Brown, later repeated in Boston. As a scientist, it is said that he made few discoveries. His exact knowledge in this domain, however, was gained at first hand; his works abound in interesting observation and fragments of natural history; notwithstanding that when he came to report nature he seems to have valued it largely for what it interpreted to him. He was much of a poet, but lacked metrical facility, and wrote little. Some of his work in verse, such as 'Smoke,' which Emerson thought finer than anything of Simonides, is of a high order. In prose, despite exaggerations and other rhetorical defects, he attained greater certainty of expression. Throughout his writings there is a tonic quality which may in part arise from what John Burroughs, the chief later representative of the school of literary naturalists which Thoreau inaugurated, calls his «stimulating contrariness.» The 20th century has brought a greater appreciation of Thoreau, especially of his prose works, which now appear destined to outlive those of his contemporaries. (See WALDEN). There is a 'Riverside' complete edition (1893); an edition of the 'Letters' by Sanborn (1894). A complete edition appeared in 1906. Consult also Channing, W. E., 'Thoreau, the Poet-Naturalist' (1873; new ed., 1902); Sanborn's 'Life' ('American Men of Letters Series,' 1882); the 'Lives' by Page (1877) and Salt (1890; 1896); Japp, A. H., 'Thoreau: His Life and Aims' (Boston 1877); Marble, A. R., 'Thoreau: His Home, Friends and Books' (New York 1902); More, P. E., 'Shelburne Essays, First and Fifth Series' (New York 1907–08); Payne, W. M., 'Leading American Essayists' (New York 1910); Rickett, A., 'The Vagabond in Literature' (New York 1906); Sanborn, Frank B., 'A Life of Henry D. Thoreau' (New York 1916); Torrey, Bradford, 'Friends on the Shelf' (Boston 1906); an essay by Burroughs in 'Literary Values' (1903), and also lives of Emerson, A. Bronson Alcott and Hawthorne.

THORIANITE, a mineral consisting chiefly of thorium and uranium oxides, about 71 per cent of the former and 12 per cent of the latter, occurs at Norris, Madison County, Mont.

THORITE, a rare but important mineral found almost exclusively in Norway. Theoretically it is an anhydrous thorium silicate, $ThSiO_4$, but all analyses show the presence of considerable water and more or less uranium, lead and iron. The variety orangite, which is of a bright orange to lemon-yellow color, is the richest known thorium ore, containing by analysis 71.65 per cent of thoria. Uranothorite has a dark reddish-brown color and contains 9 to 10 per cent of uranium sesquioxide. Thorite proper is black or very dark brown. It crystallizes in tetragonal crystals isomorphous with zircon, the usual habit being a square prism terminated by a square pyramid. Prismatic cleavage is distinct and the fracture is conchoidal. Its hardness is 4.5 to 5, and the specific gravity ranges from 4.2 in some uranothorite to 5.4 in some orangite. It is transparent in thin splinters to nearly opaque in large or altered masses. Its lustre is resinous, streak yellow to dark brown. Thorite was formerly one of the chief sources of supply of the rare earth thoria and is still of much value for that purpose, though its use has been supplanted.

THORIUM, one of the most valuable of the rare elements. It was discovered by Berzelius in a Swedish mineral and called by him «thorium» after the ancient Swedish god Thor. Found in the minerals thorite, orangite, euxenite, aureite and in monazite sand. This latter substance is found in considerable quantity in Brazil and in North Carolina and is one of the most valuable sources of thorium and of a number of other rare elements related to it. Thorium, symbol Th, atomic weight 232, is a grayish metallic element that can be separated in an elementary condition by heating the chloride, $ThCl_4$, with metallic potassium or sodium. It is soluble in mineral acids and burns brilliantly to the oxide ThO_2, thoria, when heated in the air. This oxide is the most important compound of thorium as it is used together with the oxides of certain other rare elements to form the «mantles» for the Welsbach incandescent gas lights. See MINERAL PRODUCTION OF THE UNITED STATES.

THORN, tōrn, Germany, in Prussia, in the province of West Prussia, on the Vistula, 51 miles southwest of Marienbad. It is an important stronghold, the head of the eighth Prussian fortress district, a railway junction, surrounded by detached forts, and has withstood many sieges, the last being in 1915. It dates from 1231, and its principal buildings comprise the ancient castle, town-house and other gabled and handsome edifices; there is also a statue to Copernicus, who was born there. It was taken from Poland by Prussia in 1793. Its manufactures include machinery, castings, soap and a special gingerbread. There is considerable trade in corn and timber, besides wood, linen, hides, bark and ashes. An important conference was held in 1645 to reconcile Protestant and Catholic differences, presided over by German and Polish churchmen, but was far from meeting with success. Pop. 46,227.

THORN-APPLE. See DATURA.

THORNDIKE, Edward Lee, American psychologist: b. Williamsburg, Mass., 31 Aug. 1874. He was educated at Wesleyan University (A.B., 1895), Harvard (A.B., 1896), Columbia (Ph.D., 1898), and taught in the Western Reserve University (1898–99). He became instructor in psychology in Columbia University (1899–1904) and has been professor there since the latter year. He is author of 'Educational Psychology' (1903); 'Mental and Social Measurements' (1904); 'Animal Intelligence' (1911); 'The Original Nature of Man' (1913); 'The Psychology of Learning' (1914), and many monographs on similar subjects.

THORNE, Joseph, American inventor: b. Marlborough, N. Y., 17 Feb. 1826; d. Sing Sing, N. Y., 4 May 1897. He served through the

Mexican War. Becoming an engineer he associated himself with Elias Howe while the latter was perfecting his sewing-machine. Afterward he was connected with the Singer Company and later established a factory in Scotland. He invented a typewriter, a sewing machine and a typesetting and distributing machine, which bear his name. This last machine was developed in Hartford, Conn. See COMPOSING MACHINES.

THORNHEADED WORMS, or **ACANTHOCEPHALA,** a group of parasitic roundworms (q.v.) of the genus *Echinorhynchus,* having the proboscis armed with a circle of hooks.

THORNHILL, SIR **James,** English painter: b. Melcombe Regis, 1676; d. Thornhill, Dorset, 13 May 1734. Queen Anne appointed him her sergeant-painter and he was much engaged in the decoration of palaces and public buildings, in which his chief works are to be found. Among his best efforts may be mentioned the dome of Saint Paul's, Great Hall at Greenwich Hospital and some rooms at Hampton Court. He also painted the altar-pieces at All Souls and Queen's colleges, Oxford. His forte was in the treatment of allegorical subjects. He was confirmed in his position sergeant-painter by King George I in 1720 and knighted in the same year. Hogarth clandestinely married Thornhill's daughter in 1729, and always expressed great admiration for that painter's works which show invention, even genius, although living critics have not confirmed the favorable verdict of George I and his contemporaries.

THORNS AND SPINES IN PLANTS, acute-pointed projections from the trunks, branches or twigs of plants. A thorn arises from the wood of which it is an outgrowth, whereas a prickle or spine is an outgrowth of the bark and can be removed when the bark is peeled off. The raspberry and the rose are good examples of prickle-covered plants; the hawthorn and some wild plums of plants covered with thorns. Prickles and spines are believed to be useful to the plants which bear them, either as protections against the browsing of animals, as auxiliaries in climbing, holding their position, etc.; thorns are considered to be abortive branches, a deduction based upon the facts that in nature they often bear leaves, and under domestication may develop into branches. Various hawthorns exhibit the former phenomenon and the apple and pear the latter.

THORNTON, SIR **Edward,** English diplomat: b. London, 13 July 1817; d. there, 26 Jan. 1906. He was educated at King's College, London, and at Cambridge University and in 1842 was appointed attaché at Turin. He was engaged in important diplomatic missions to Mexico and the South American states in 1845–65, and in 1865–67 was Minister to Brazil. In 1867 he was appointed Minister to the United States, served on the commission to adjust the Alabama Claims in 1871 and was arbitrator in the commission on the United States and Mexican claims in 1873. He became Ambassador to Russia in 1881, to Turkey in 1884 and in 1887 retired from the diplomatic service.

THORNTON, John Wingate, American author: b. Saco, Me., 12 Aug. 1818; d. Scarboro, Me., 6 June 1878. He took his LL.B. degree at Harvard in 1840; was admitted to the bar and practised in Boston. The honorary A.M. degree was conferred on him bv Bowdoin College in 1860. He was the founder of the New England Genealogical Society and was vice-president of the American Static Association. His published works chiefly include genealogical memoirs of distinguished men and families, including a 'Life of John Bowles,' 'Ancient Pemaquid,' 'Pulpits of the American Revolution' (1860) and the 'Historical Relations of New England to the English Commonwealth' (1874) Consult 'Memoirs of John Wingate Thornton' (Boston 1879).

THORNTON, Matthew, American legislator, signer of the Declaration of Independence: b. Ireland, 1714; d. Newburyport, Mass., 24 June 1803. He came with his parents to America in 1717, lived for a time at Wiscasset, Me., removed to Worcester, Mass., and there received his education. Entering the profession of medicine, he practised at Londonderry, N. H., and in the Louisburg expedition under Sir William Pepperell (1745) served as surgeon. He presided over the provincial convention of 1775; in 1776 became a delegate to the Continental Congress; and although he did not take his seat until November, and had not been elected when the Declaration of Independence was adopted, he was granted the special privilege of signing it. He had already been chief justice of the Court of Common Pleas in New Hampshire when in 1776 he was made a judge of the Supreme Court, and this office he held until 1782.

THORNTON, William, American architect and physician: b. Tortola, West Indies, 1762; d. Washington, D. C.,1827. He was educated as a physician and resided for a number of years in Philadelphia where he was well known for his scientific attainments and was a member of the American Philosophical Society. He was a skilled architect and designed the Philadelphia Library building. Later he removed to Washington and planned the Capitol, of which he partly supervised the construction. He was the first commissioner of public buildings at the national capital and also was first Commissioner of the patent office, to which he was named in 1802. He wrote 'Cadmus or the Elements of Written Language' (Philadelphia 1913).

THORNWELL, James Henley, American educator: b. Marlborough District, S. C., 9 Dec. 1812; d. Charlotte, S. C., 1 Aug. 1862. He was graduated in 1831 from the South Carolina College and studied law but declined to practise and finally was ordained by the Bethel Presbytery in 1834 and became pastor of the Lancaster Court House congregation. He was professor of logic, *belles lettres* and metaphysics in the South Carolina College (1837–39), pastor at Columbus, S. C. (1840), returning to the college as professor of literature (1842–52). In 1841 he visited Europe. He served as president of the South Carolina College (1852–55). He was author of a number of works treating of theological subjects and his writings, edited by Rev. J. B. Adger were published in 1874. Consult Palmer, Ben, 'Life and Letters' (Richmond 1875).

THORNYCROFT, Sir **John Isaac,** English engineer and naval architect: b. Rome, Italy, 1 Feb. 1843. He was graduated from the engineering department of Glasgow University and studied shipbuilding at Govan on the Clyde. He became a builder of torpedo boats and has constructed many such boats for English and other European governments. He is the inventor of the turbine-propeller for use in shallow-draft vessels; and was knighted in 1902.

THORNYCROFT, William Hamo, English sculptor: b. London, 9 March 1850. He received his education at University College School, London, and entered the Royal Academy schools in 1869. He first exhibited at the Academy in 1871 and in the same year went to Italy. He gained a gold medal from the Academy in 1875 for a group representing 'A Warrior Bearing a Wounded Youth From the Field of Battle' and in 1880 he completed his 'Artemis' for the Duke of Westminster. He became R.A. in 1888. He was made an honorary member of the Royal Academy of Munich in 1889 and he received a *médaille d'honneur* at the Paris Exhibition of 1900. His principal works include, in addition to those mentioned, 'Teucer' (1881), now in the Tate Gallery; 'The Mower' (1884); a memorial of the poet Gray (1885) at Pembroke College, Cambridge; a bust of S. T. Coleridge (1885), in Westminster Abbey; 'The Sower' (1886); the National Memorial to General Gordon in Trafalgar Square, London; 'Medea' (1888); a statue of John Bright (1890) in Rochdale; 'The Bather' (1898); 'Lot's Wife'; and many monumental statues, including those of Queen Victoria, Archbishop Thomson (York Minster) and W. E. Gladstone (1902). The style of this sculptor shows a return from pictorial realism toward the severity of Greek idealism. His monumental statues, the best of which is that of Gordon, are some of the noblest in English art, and his heroic figures, such as 'Teucer,' are instinct with life, while exhibiting something of the purity of line and classic grace which belong to the Periclean age of sculpture.

THORODDSEN, thôr'ŏd-sĕn, **Thorvald,** Icelandic physicist: b. Flatey, Breidifjord, West Iceland, 6 June 1855. He was educated at the College of Reykjavik and the University of Copenhagen and was a teacher at the first-named institution, 1885–95. Since the last-named date he has resided in Copenhagen, spending his summers in Iceland, and has made a geological survey of the entire island. Among his publications are 'History of Icelandic Geography' (1892–1902); 'Geological Map of Iceland' (1901); 'Earthquakes in Iceland' (1899); 'History of Icelandic Volcanoes' (1882).

THOROGUMMITE, a rare mineral found only in Lano County, Tex. It is essentially a hydrated thoro-silicate of uranium, containing also ceria, yttria, lead, etc. It is regarded as made up of three molecules of thorite, linked with one of uranic oxide. It is highly valuable as an ore of uranium and thorium. It occurs massive or in crude crystals resembling thorite in form. Its color is dull yellowish-brown; hardness, 4 to 4.5; specific gravity, 4.43 to 4.54.

THOROLD, Canada, town in the province of Ontario, on the Grand Trunk Railroad (Welland branch) and the Niagara, Saint Catherine and Toronto Electric Railway, 26 miles northwest of Buffalo, N. Y. It has four churches, several big flouring mills, a foundry, cement, woodworking and paper mills, knitting, printing and publishing establishments, telegraph offices and ample hotels, a bank and a public library. Pop. about 2,500.

THOROUGHWORT. See Eupatorium.

THORPE, thôrp, **Francis Newton,** American author and jurist: b. Swampscott, Mass., 16 April 1857. He was educated at Lake Shore Seminary, at Syracuse University (Ph.D., 1883; LL.D., 1907). He was Fellow and professor of American constitutional history of the University of Pennsylvania (1885–98) and University of Pennsylvania Law School (1885–86); has been professor of political science and constitutional law, University of Pittsburgh, since 1910. Mr. Thorpe is author of 'The Story of the Constitution' (1891); 'A Constitutional History of the American People, 1776–1850' (2 vols., 1898); 'The Constitutional History of the United States, 1765–1895' (3 vols., 1901); 'A Social and Industrial History of the American People' (1901); 'A History of the United States for Schools' (1902); 'A Short Constitutional History of the United States' (1904); 'The Civil War: The National View' (1906); 'History: The Career of Man on the Earth' (1909); 'The Government of the People of the United States' (1889); 'A Course in Civil Government' (1894); 'The Government of Pennsylvania' (1894); 'The Constitution of the United States With Bibliography for Students of Political Science' (1894); 'The Statesmanship of Andrew Jackson' (1909); 'The Federal and State Constitutions, Colonial Charters and Other Organic Laws of the States, Territories and Colonies Now or Heretofore Forming the United States of America' (7 vols., published by Act of Congress, 1909); 'Benjamin Franklin and the University of Pennsylvania' (1893); 'Franklin's Influence in American Education' (1903); 'The Home and the Household' (1910); 'Business' (1910); 'William Pepper, M.D., LL.D., Provost of the University of Pennsylvania' (1904); 'William Hickling Prescott' (in 'Studies of Great Authors,' 1899); 'The Spoils of Empire' (1903); 'The Divining Rod' (1905); 'An American Fruit-Farm: Its Selection and Management for Pleasure and for Profit' (1915); 'The Essentials of American Constitutional Law' (1917), etc.

THORPE, Rosa Hartwick, American author: b. Mishawaka, Ind., 18 July 1850. She was graduated from the high school, Litchfield, Mich., in 1868, and was married to E. C. Thorpe in 1871. She is widely known by her poem 'Curfew Shall not Ring To-night.' She has published among other works 'Fred's Dark Days' (1881); 'The Year's Best Days' (1889); 'Ringing Ballads' (1887); 'Sweet Song Stories' (1898).

THORWALDSEN, tôr'wâld-sĕn, **Albert Bartholomew (Bertel),** Danish sculptor: b. Copenhagen, 19 Nov. 1770; d. there, 24 March 1844. His father, an Icelander, was employed in the royal dockyard at Copenhagen in cutting figure-heads for vessels, and little Thorwaldsen's first employment was in helping his father. In his 11th year he entered the Academy of Arts, where he gained in 1793, along with a medal, the privilege of studying three years abroad. He resolved to visit Rome, where he arrived in November 1797, and under the inspiration of Canova and Carstens the painter devoted himself to reproducing that ideal beauty of ancient statuary, which became ever after the one object of his artistic life. It was not until 1803 that he became at all widely known. He had finished a model of Jason without finding a purchaser, when the well-known and wealthy Thomas Hope called at his studio and arranged with him to have it executed in marble. The fortune of its designer was now made. Commissions flowed rapidly in upon him, new creations from his hand followed in quick succession and his abilities as a sculptor became everywhere recognized. In 1819 he returned to Denmark, and his journey through Germany and his reception at Copenhagen bore the appearance of a triumph. His first works in this city were the busts of the king and queen. He was next employed by the commissioners for the rebuilding of the Fruekirke or church of Our Lady, to design the decorations for the same, which now form its main ornament. In 1820 he returned to Rome, visiting on his way Berlin, Dresden, Warsaw and Vienna, and receiving numerous orders for works. He remained at Rome till 1838, when he undertook another journey to Copenhagen, being principally moved to this step by the contemplated establishment in that city of a museum of his works and art treasures. His return was a true national festival, both for Copenhagen and the whole of Denmark. With the exception of a short visit to Rome the remainder of his life was spent in the Danish capital, and he both took a vivid interest in the establishment of the Thorwaldsen Museum (q.v.) and enriched it by important contributions. Consult Thiele, ‹Thorwaldsen's Biographie› (1856); Plon, ‹Thorwaldsen sa Vie et ses Œuvres› (1867); both of these works have been translated into English; Hammerich, ‹Thorwaldsen und seine Kunst› (1876).

THORWALDSEN MUSEUM, a building and art collection at Copenhagen raised from funds left by the sculptor Thorwaldsen. The building was constructed after a plan furnished by the architect Bindesböll, and is purely Greek in style. In contains the models and works bequeathed by the sculptor to his native city, which comprise 80 statues from his hand; three long alto-relievos and 130 busts. In the centre of the building is the highly decorated tomb of Thorwaldsen. The museum was opened in 1846.

THOTH, thŏth or tōt, an Egyptian deity identified by the Greeks with Hermes. He was originally the moon-god, and the invention of letters, arts and sciences was attributed to him. The ibis was sacred to him and he is represented with the head of that bird, and with the tau cross in his hand. The dog-headed ape is also one of his attributes, and he is frequently depicted with a dog's head. There were 42 sacred books bearing his name, which were under the guardianship of the Egyptian priests. These books he is said to have composed; and he accordingly appears in the monuments with tables and stylus. He has been identified with the Greek Hermes. See HERMES TRISMEGISTUS.

THOTHMES, thŏth'mēz or tōt'mēz (son of Thoth); the name of four Egyptian kings. Under Thothmes I, Egypt saw its darkest days come to end with the expulsion of the Hyksos, and the revival of truly national art and civilization and of national power. The era of foreign invasion, with the consequent enrichment of the royal treasury, began. Ethiopia was made a tributary state, and eastward the limits of Egyptian power were pushed as far as to the Euphrates. At his death Thothmes I was succeeded by Thothmes II, his eldest son, with Hatasu, his daughter, and Thothmes III, his younger son, as coregents. Thothmes II beautified Thebes, but his reign was brief and insignificant. Thothmes III was the Alexander of Egyptian history. After the death of Hatasu he entered upon that series of wars which comprised 14 campaigns, in the course of which he subdued Palestine, Syria, Mesopotamia in part, and large tracts of territory between the Euphrates and the Mediterranean. The names of the cities he took, including Megiddo and Tyre, are inscribed in his triumphant self-eulogy on the walls of Karnak. He added extensively to the architectural glories of Thebes. As Hatasu, the Semiramis of Egypt, erased the name of the Thothmes II, her half-brother, from his monument at Karnak, so was her name erased with the record of her campaigns, during which she appeared in male attire, from the recording inscriptions by Thothmes III. He reigned from 1503 to 1449 B.C. He was succeeded by Amenhotep II at whose death Thothmes IV began his reign. The latter waged war in Ethiopia, Syria and Phœnicia, but his career was without national or political significance. Consult Breasted, J. H., ‹History of the Ancient Egyptians› (New York 1908).

THOU, too, **Jacques Auguste de** (in Latin, THUANUS), French magistrate and historian: b. Paris, 8 Oct. 1553; d. 7 May 1617. On the revolt of Paris, produced by the violence of the League, he adhered to Henry III, and after the assassination of the Duke of Guise, was principally instrumental in reconciling Henry with the king of Navarre. In 1595 he succeeded his uncle as chief justice, and immediately registered in anticipation of the Edict of Nantes, which he assisted in preparing, the Edict of Saint Germains in favor of the Protestants. In the regency of Mary de Medici he was appointed one of the directors-general of finance, and otherwise employed in nice and difficult matters, in which he was conspicuous for integrity and ability. His greatest literary labor was the composition in Latin of a voluminous ‹Historia sui Temporis,› of which the first part appeared in 1604. When finished it consisted of 138 books, comprising events from 1545 to 1607. It is remarkable for its general impartiality. To this he added ‹Commentaries,› or memoirs of his own life, composed in the same spirit. The most complete edition of the history is that published in London in 1733, by Buckley, in seven volumes. Consult Collinson, ‹Life of Thuanus, with some Account of his Writings› (1807).

THOUGHT, a cognitive relation other than that of direct awareness, born by the mind either toward an object which is believed to exist, or toward a so-called "abstract object," such as a universal, concerning which the question of existence has no meaning. This latter feature distinguishes thought from imagination in the narrower sense which is directed toward objects capable of existence, without involving any belief in their existence. Since it differs from mere presentation, the thought-relation, so far as it furnishes us with any knowledge of its objects, furnishes us with what Bertrand Russell calls knowledge by description — knowledge that is, which may be expressed by propositions. On this account thought can be conveyed by language, for language, though totally unable to transmit an immediate presentation, is well adapted as a vehicle for the relations between presentations, as embodied in propositions. This intimate association between thought and language leads to the nominalist identification of the two, which possesses all the defects inherent in every form of nominalism (q.v.). A more vicious form of this nominalism pervades a large part of the modern psychology of reasoning and consists in the recognition in the mental life of nothing but particulars. The fundamental method of psychology is, of course, introspection. Now, the psychologist receives his training in introspection in the domain of the senses. Here introspection means for the most part the formation of an inventory of the sense-data constituting a given experience. The psychologist consequently acquires the tendency to consider the analysis of consciousness complete when all the mental states of the level of sense-data are checked off and tagged. When he approaches an act of thought, or the consciousness of a universal, or any similar experience, he is likely to find such mental states as he is accustomed to examine, entirely absent, except for a few vague residual organic or kinæsthetic sensations and verbal images. He, therefore, identifies these with the thought-consciousness or universal-consciousness and either concludes that these forms of consciousness add to the mind no constituent elements not already found in sensation, memory, imagination and feeling, or postulates the existence of some substantive mental state not involving images or emotions. Unable to explain how such a barren mental state can be so pregnant with meaning, he has recourse to such unexplanatory phrases as "conscious attitudes." The true reason for the ability of a vague picture of a particular triangle to convey the entire meaning of triangularity, or for power of a verbal image of the law of gravitation to symbolize the law itself, is that the mind is a structure and no structure is exhausted by its inventory.

There is no doubt on earth that whether the consistency or the correspondence theory of truth be valid, a necessary condition of true thinking is that the pattern of thought should agree with the pattern of things. Now, if two patterns agree, we do not have the relations of the parts of one pattern symbolized by the parts of the other, but precisely by the relations between those parts. Accordingly, it is only reasonable to suppose that relations are conveyed in the mind, not by items, but by relations; that qualities are conveyed by qualities; that facts are conveyed by facts. The muscular strain in the orbits that may be the only substantive state in my mind when I think of a certain mathematical theorem is not my consciousness of that theorem, but merely a sort of a mental chalk-mark with which I make myself aware of my reference to the theorem. To call my true consciousness of the theorem either imageful or imageless involves a gross confusion of categories. (See LOGIC; MEANING; PSYCHOLOGY). Consult James, W., 'Principles of Psychology' (New York 1890); Messer, A., 'Empfindung und Denken' (Leipzig 1908); 'Psychologie' (Stuttgart 1904); Ogden, R. M., 'Introduction to General Psychology' (New York 1910); Titchener, E. B., 'Experimental Psychology of the Thought-Processes' (New York 1909).

THOUGHT TRANSFERENCE. See TELEPATHY.

THOUSAND ISLANDS, a group of islands in the Saint Lawrence River (q.v.), near Lake Ontario. For about 40 miles east of Ontario the Saint Lawrence has a width of three to seven miles and here there are about seven large and 1,600 small islands. The belt of Laurentian gneiss which extends from the Adirondacks in New York into Canada is here crossed by the Saint Lawrence River. The crystalline rock and glacial deposit forming the river bed presents an uneven surface; some of the points being above the water form islands. A large number of the islands belong to Canada, the others to the State of New York. Handsome summer residences have been erected on many of the islands and large hotels furnish accommodations for the many city people who visit the place each summer.

THOUSAND AND ONE NIGHTS, The. See ARABIAN NIGHTS, THE.

THRACE, thrās, anciently a part of the Balkan Peninsula, whose territory was somewhat indefinite, but which comprised the region north of Macedonia, including Scythia. Its territory was understood differently at different times by the ancients, but was later limited to the country between the northern boundary of Macedonia and the Danube and that which lies between the Black Sea, the Bosporus, the Propontis and the Hellespont, the Ægean Sea and the Strymon River. The Balkans divided it into two parts — the Romans recognized only the southern division as Thrace. The land was inhabited by wild tribes, abounded in mines, had fertile lands and produced celebrated horses. The chief mountains were the Hæmus (Balkan), Rhodope and Pangæus. The largest river, the Hebrus or Maritza. The chief towns, Abdera where Democritus was born; Sestos and Byzantium. The mythological founders of Greek poetry, music and philosophy are supposed to have come from Thrace. The Thracians were classed as barbarians up to about 475 B.C., when Xerxes invaded the country and introduced some Eastern customs. His rule was short, but Philip of Macedon in the 4th century occupied a portion of the territory, and in 133 B.C. it came under the power of Rome. Native kings maintained a nominal rule, however, for several centuries. About 335 A.D.

Constantine sent a colony of Sarmatians to Thrace and continued to colonize the country. A few years later Thrace was overrun by the Goths and later by Attila and his Huns. In the following centuries a Bulgarian population developed, and about 1450 the country came under Turkish rule. For modern history see BULGARIA; BALKAN PENINSULA; SERBIA.

The Thracians can hardly be regarded as a distinct race, being a mixed people much confused with the Illyrians. The early tribes were low in morals and addicted to phallic worship. Their dialects were closely allied to the Greek. The native deities were Ares, Bendis and Dionysius. See ILLYRIA.

THRASHER, one of the large, thrush-like wrens of the American genus *Harporhynchus*, of which the familiar Eastern species is the brown thrasher (*H. rufus*), one of the most pleasing of American migratory birds. It is about 10 to 12 inches in length, slender, with a long bill and tail, rufous upper parts and a cream-white breast sharply marked with arrow-shaped streaks. A frequenter of orchard and shade-trees, it is as likely to make its nest on the ground or upon bush-piles near the house as at the edge of the woods, and its oblong pepper-and-salt sprinkled eggs are familiar to every country boy. The thrasher in spring utters a highly varied song, so brilliant and full of startling phrases of melody and apparent mimicry that it fairly rivals the performance of the mocking-bird itself. While it eats some grain, it is tolerated because it is destructive to various grasshoppers, worms and bugs. The genus contains several other well-marked and interesting species of the West and Southwest. Consult Coues, ‘Birds of the Southwest’ (Washington 1879); Forbush, E. H., ‘Useful Birds’ (Boston 1913) and ornithologies of the United States generally.

THRASYBULUS, thrăs-ĭ-bū'lŭs, Athenian general and democratic leader: d. about 390 B.C. He was a friend of Alcibiades, whose recall from exile he obtained. In 411 B.C. he commanded a galley in the fleet at Samos, joined in the opposition to the oligarchy of the Four Hundred and exacted an oath from the Athenians in the fleet to uphold democratic government. At the battle of Cynossema he commanded the right wing and secured the victory by a sudden attack upon the Peloponnesians. In 407 B.C., with a fleet of 30 ships, he reduced most of the revolted cities on the coast of Thrace to submission and about the same time was with Alcibiades elected one of the new generals. Banished on the establishment of the Thirty Tyrants, he seized, with the aid of some Thebans, the fortress of Phyle and with an increased force occupied the Piræus. After the accession of the Ten he was defeated by Lysander and Libys, but, together with all who had joined him, was saved from punishment by the contrivance of Pausanias. In 395 B.C. he led an army to the assistance of the Thebans, then menaced by Sparta, and five years later was sent with 40 ships to aid the Rhodians against Teleutias, restored the Athenian interest in Byzantium, secured several new alliances and reduced Methymna and other towns in Lesbos. Afterward sailing south, he anchored in the Eurymedon, near Aspendus in Pamphylia, when the inhabitants, exasperated by some act of his soldiers, fell upon him in the night and killed him.

THREAD. The filaments of fibrous substances spun out for weaving are in a general sense called threads, the specific name of such filaments being yarn. Thread in a specific sense consists of two or more filaments of yarn twisted together for greater strength; when the filaments do not exceed two this is called doubling and the manufacturing process is doubling and twisting. Doubled yarn or thread is used in some sorts of weaving, especially in that called bobbin net, but its principal use is for sewing. When manufactured for this purpose it is specifically known as sewing thread. A large proportion of sewing thread is simply doubled yarn and the processes of yarn doubling and of the manufacture of sewing thread are substantially the same, but thread for sewing purposes often requires to be stronger and firmer in texture than doubled yarn and then three, four and six strands of yarn of fineness proportioned to the thickness of the thread required are used to produce it. The manufacture of sewing thread in the United States is very extensive. The chief seat of the cotton thread manufacture in Scotland is Paisley; in England, Manchester. Linen thread is manufactured largely in Ireland. Cotton was first used in the manufacture of sewing thread at Pawtucket, R. I., by Samuel Salter in 1794. Flax had always been used everywhere, but as Mrs. Salter was spinning cotton she noticed the fineness of the fibre and at once conceived that it would make smooth thread. The idea was put into practice. The operation of «spinning» cotton is really making thread for weaving. A loose cotton called a «roving» is drawn out into a filament or yarn and twisted and wound on bobbins that later go to the weaving machine. See COTTON MANUFACTURES IN THE UNITED STATES.

THREADCELLS. See NEMATOCYSTS.

THREADNEEDLE STREET, London, England, the short thoroughfare faced by the Bank of England, which is proverbially called «The Old Lady of Threadneedle Street.» The name is supposed to be derived from the three needles on the coat-of-arms of the Needlemakers' Guild.

THREADWORM, a common name often used for any of the Nematoda (q.v.). It is distinctly inappropriate when applied to the thick fleshy species like Ascaris and belongs properly to filiform nematodes, especially the Filariidæ. In medical usage the term ordinarily designates the pinworm (Oxyuris) or the whipworm (Trichuris), common intestinal parasites of man. See ROUNDWORMS.

THREAT is defined in law as a menace of destruction or injury to the lives or property of those against whom it is made and may be the subject of a civil action for damages or frequently an equitable action may be maintained to restrain threats and intimidations. One who is induced by threats to enter into an agreement, pay money or do any other act, which in itself is lawful, may by proper means avoid the consequences of such act, same having been performed under duress. One who threatens to do another a bodily harm or to take the life of another may be required to give bond to keep the peace; to threaten a court, or anyone under its immediate protection, is punishable; and in some jurisdictions to obtain a pecuniary advantage by threat is a punishable offense, as is also a threat to accuse one of a crime for the purpose of obtaining money. In many of the United States the offense of sending threatening letters for the purpose of obtaining money is punishable and it is contrary to the postal laws of the United States to send upon the outside of any mailable matter any printed or written threatening language and one is punishable who assists knowingly in forwarding threatening letters. See BLACKMAIL; CORRUPT PRACTICES ACTS.

THREE-COLOR PROCESS. See COLOR PRINTING; PRINTING; ENGRAVINGS.

THREE FATES, The. See NORNS.

THREE HOURS' AGONY, or THREE HOURS' SERVICE, a devotion practised on Good Friday, from noon till 3 o'clock in the Roman Catholic and some Protestant Episcopal churches in commemoration of the Passion. It was introduced by Father Messia, S.J., of Lima, about 1730, and reached Rome in 1738. It was introduced into the English Church about 1865 and was rendered legal by the Act of Uniformity Amendment Act (1872), which permits additional services, consisting of any prayers from the Liturgy or Bible, with address or sermon and hymns.

THREE KINGS, the men who came from the East to adore the Infant Jesus (Matt. ii, 1–12). They are probably called kings from Psalm lxxii, 10, which verse is used in the services of Epiphany. They brought offerings of gold, frankincense and myrrh and according to tradition their names were Gaspar, Melchior and Balthasar. On their return to the East they received baptism. The Empress Helena is said to have brought their bones to Constantinople, whence they were removed to Milan, and afterward to Cologne. In the chapel of the Three Kings, built by the Emperor Maximilian (1459–1519), in Cologne Cathedral, are exhibited their crowns and the shrine is supposed to contain their relics.

THREE-MILE LIMIT. See INTERNATIONAL LAW.

THREE MUSKETEERS, The. If a vote were taken in Europe and America as to the best historical romance ever penned there can be little doubt that it would favor 'The Three Musketeers' ('Les trois Mousquetaires') of Alexandre Dumas. Published in 1844, just three decades after 'Waverley,' this work exemplified Scott's theory of the historical novel to perfection. It focussed interest upon certain minor figures whose fate was linked with that of famous personages and great movements of a bygone day. Unlike the fictions of Scott, however, it freely ordered and changed the facts of history, implying the romancer's emancipation from actuality and his right to shape his story at will so long as it should reflect in general the spirit of the time represented. Dumas had read the 'Mémoires de M. d'Artagnan,' by Gatien Courtilz de Sandras (Cologne, 1701–02). His imagination, thus incited, played over the period of Richelieu's ascendancy, and with unflagging verve and brilliance he described what might have happened to a more courageous and chivalrous d'Artagnan caught in the counter-currents of amorous and political intrigue in 1628.

The plot turns upon the enmity between the queen of Louis XIII and his Minister, Richelieu. The latter seeks to control the queen through his knowledge of her love for Buckingham, attested by her bestowal upon the English lord of certain diamonds, the gift of her husband. Richelieu, for his own ends, arouses the jealousy of the king, who demands that the queen wear the diamonds at a state ball. It behooves the queen, therefore, to recover the gems in all haste, and the difficult mission is undertaken by d'Artagnan and his gallant friends, the three guardsmen. After encountering well-nigh insuperable obstacles d'Artagnan succeeds, but he incurs the enmity of Richelieu's most dangerous agent, Milady Clarik. He falls enamored of her, yet escapes her toils — assassination and poison — only to learn that she is the cardinal's emissary sent to England to threaten Buckingham with exposure unless he will cease his efforts to aid the besieged Huguenots of La Rochelle. D'Artagnan and the musketeers, thereupon, thwart Milady, who, languishing in prison, ere long prevails upon her Puritan jailer to release her and to achieve the murder of Buckingham. Then she contrives to poison d'Artagnan's sweetheart, but, pursued by the avenging guardsmen, is overtaken and adjudged to suffer death for her many crimes. Richelieu, secretly pleased to be relieved of so wicked an ally, pardons d'Artagnan and commissions him a lieutenant of the musketeers.

From first to last, the romance moves at a rapid pace in a world of passion and daring, of hot blood and ready swords, of intrigue and revenge, of jaunty heroism, of splendid loyalty and of dauntless love and friendship. It kicks up its heels, too, now and then, in the mood of rollicking humor. For all its departures from historic fact, it paints in vivid colors a living picture of France in the 17th century. Especially memorable are its portraits. Though Milady prove the villain of melodrama in petticoats, she is far from being a mere lay figure; and Buckingham, Richelieu, the queen, even the lackeys of d'Artagnan and the musketeers, above all these gallant gentlemen themselves, are vital creations. D'Artagnan, the impetuous and generous Gascon, is well matched by his friends, the shrewd and dainty Aramis, the boastful and dandified Porthos, and the melancholy Athos. It is small wonder that the four should have enthralled the minds of readers of every race and clime, and that Dumas, yielding to popular demand, should have continued their adventures in 'Twenty Years After' (1845) and the 'Vicomte de Bragelonne' (1848–50). These sequels and 'The Three Musketeers' are discussed in monographs on Dumas, in French, by Glinel (1884), de Bury (1885), Parigot (1902) and Lecomte (1904), and in English by Fitzgerald (1873), Spurr (1902) and Davidson (1902). The relation of Dumas to Scott is made clear in Louis Maigron's 'Roman historique en France' (1898).

FRANK W. CHANDLER.

THREE-PHASE SYSTEM. See Electrical Terms.

THREE RIVERS, Canada, city, port of entry and county-seat of Saint Maurice County, Quebec, on the north bank of the Saint Lawrence River at its junction with the Saint Maurice, 90 miles below Montreal, 66 miles above Quebec, and on the Canadian Pacific, and connected by ferry with the Grand Trunk Railway. By the French generally named Trois Rivieres. It has a large export trade in lumber and wood-pulp, the Shawanegan and other falls of the Saint Maurice being extensively utilized as water power for these industries; a large iron works, and important manufactures of foundry products and machinery, and other manufactures. The Roman Catholic cathedral is an imposing structure; other handsome buildings are the bishop's palace, the college and several convents, schools, and churches. The city is lighted by gas and electric lights and has hotels, banks and semi-weekly and weekly newspapers. Three Rivers was founded by Champlain in 1634, and a battle was fought here, 8 June 1776, between the Americans and British. The former were outnumbered and defeated. Pop. 13,691.

THREE RIVERS, Mich., manufacturing town in Saint Joseph County, on the Michigan Central Railroad, and at the junction of the Saint Joseph, Portage and Rocky rivers. It has car-building shops, railroad-supply factories, manufactures marine engines, knit goods, tools and paper pulp, and has foundries and brass and machine shops. There is a handsome Carnegie library. Pop. about 5,000.

THREE-WIRE SYSTEM. See Electrical Terms.

THREMMATOLOGY. A term proposed by Ray Lancaster (from the Greek *thremma,* a nursling) to cover the principles and practices connected with the improvement of domesticated animals and plants. It is distinct from evolution in general in that its ultimate purpose is utilitarian. The breeder is interested in definite results, whereas nature is supposed to be indifferent to everything but the «survival of the fittest.» The purpose then in thremmatology is not to make the creature «fit» the conditions of life, but rather to bring both the creature and conditions to harmonize with the highest needs and purposes of man.

This brings to the surface in thremmatology, as a question of prime importance, one that is curious rather than otherwise in evolution, namely: Can the conditions of life be employed directly to influence deviation in the desired direction independently of selection; in other words, can individual modification become hereditary, or as the expression goes in general evolution, are acquired characters inherited?

All students agree that the development of individuals is strongly modified by the conditions of life, that is, the environment. Out in nature if these modifications are not inherited it implies only a little more work for selection, and the final result is the same whether they are inherited or not. The answer to the question is interesting, therefore, rather than vital so long as the study is confined to general evolution; but in thremmatology the answer involves a vital principle because the breeder, especially of animals, cannot afford unlimited selection. All the animals represent money, and the owner is interested in getting results with a minimum destruction of values. He is interested, too, in securing improvements as rapidly as possible, because time is money, and man cannot afford the «countless ages» of nature. If, therefore, individual modifications are inherited, even to the slightest degree, the effect is rapidly cumulative, much time is gained and the necessity for selection is largely reduced,— both important considerations from a business standpoint. Upon the answer to this question will depend the kind of soil and climate employed in plant breeding, the daily care, the shelter, the amount and character of feed provided for breeding animals, as well as the matter of exercise and training where speed or intelligence are involved. That these are important in the development of the individual all are agreed, but it is also necessary that they be provided for breeding stock for the sake of the offspring?

Evolutionists in general are interested primarily in form, while the thremmatologist is concerned very largely, if not mainly, with function. The size or shape of the cow is of less importance than her ability to convert large amounts of feed into milk and do it economically. This faculty depends directly upon the functional ability of a very limited portion of the body and not so much upon the general form. The ability of the horse to attain high speed depends not only upon his conformation but quite as much upon the «quality» of his motor parts, whether active or sluggish, and the mental make-up, whether well balanced or erratic. Functional activity is, therefore, of much more interest in thremmatology than in general evolution, and functional variation is recognized as one of the principal opportunities for improvement.

The systematic study of thremmatology involves the following topics:

1. A working knowledge of the ordinary theories and concepts of general evolution.
2. The kinds of variation; namely, qualitative, relating merely to size; meristic, relating to pattern; and functional, relating to organic activities.
3. Continuous variation in which all values are presented for selection, and discontinuous variation in which some values seldom or never occur, as in the case of sports, in polymorphism and as it is involved in the idea of orthogenesis.
4. The causes of variation, first, as between different individuals of the same generation; second, as between different individuals of the same parentage but of different generations; third, as between different individuals of the same parentage and the same generation, as with twins, litters, etc., without regard to parentage; fourth, as between succeeding generations of the same species, representing deviation of the race; fifth, modifications in the individual during its development plainly due to the conditions of life, rather than to heredity. These different uses of the term variation should be kept distinctly in mind, and even then it is better to use the word «deviation» for the fourth, and «modification» for the fifth form of what is usually called variation. These causes will drop into two groups; first, selective mating, raising

questions touching the basis of selection; second, the environment, raising all questions of the effect of the conditions of life, acclimatization and the inheritance of modifications or acquired characters.

5. Statistical studies of heredity in order to construct the array, eliminate chance, determine the skew, study the laws of regression and progression and the relative influence of parents.

6. Correlation, as determined by correlation tables, and useful as indexes of valuable characters.

7. The practical selection of breeders accompanied by a full appreciation of the financial considerations involved, and the relation between performance and breeding powers as exhibited by livestock records.

8. The testing of sires as a final basis of selection.

9. The importance of selecting for prolific strains, among both animals and plants, and the advantages of vigor and longevity.

10. The disturbing effect of fashion, and the best methods of meeting its demands in breeding without sacrificing real quality.

It is important in the study of this phase of evolution that the breeder have in mind fairly comprehensive ideas of general evolution; that he be not a blind adherent of any peculiar dogma, and that he free his mind from a mass of traditions that serve only to cloud the judgment and deter progress. For example it has been held as a general principle that inbreeding is necessarily fatal to fecundity and to vigor; yet wheat, one of our most vigorous and prolific crops, is systematically inbred. One of the first lessons the breeder should learn, therefore, is that what is true of one species is not necessarily true of all species.

What has been accomplished by way of improvement, and it is much, has been gained almost exclusively by selection, and under disadvantageous circumstances. For example, among plants increase is so rapid as to compel sweeping selections merely for reduction of numbers, not affording opportunity for as good a basis of judgment as if more space and time were at hand. In this way some of the best things are lost. On the other hand among animals numbers are too few for the best selection and the oft-repeated attempt «to establish a small herd of high-class animals» has been as often a failure for the reason that numbers are too few to afford material for proper selection even to maintain the initial standard, to say nothing of improvement.

The well-nigh universal practice of using young sires is fatal to the most rapid progress, for in such cases the selection has been made before full development. Thus some of the worst specimens are accepted because prepossessing at an early age and many of the best are discarded which if given time to fully mature would prove their right to exist.

The practice among the better breeders today is tending toward larger numbers, better conditions of life, the selection of more mature animals, followed by an actual breeding test resulting in older sires, emphasis of those «points» that have their basis in utility, and withal an ideal standard that, once adopted, is changed but slowly, if at all.

As would be expected the most rapid progress has been made in those breeds or varieties of animals and plants in which practically all the individuals can be put to the performance test. For example, it is comparatively easy to get a record from a cow or a speed horse and to know what the one can do at the pail or the other on the track. On the other hand it is impossible to put the meat animals to the actual test without sacrificing the individual as a breeder. Accordingly breeders of beef cattle, swine and other meat-producing animals have been working somewhat in the dark and to relieve the situation many have felt obliged to sacrifice on the block some of their best bred animals in order to test their standards of selection and verify their methods of breeding.

The improvement of animals and plants is a difficult and often a money-losing enterprise, but it is fascinating because of what is possible. By breeding, the sugar content of beets has been increased from 3 or 4 per cent to 12 and even 20 or more per cent. Corn has been bred richer in nitrogen than is wheat, and its oil content is raised or lowered at will. So far as is known any character may be substantially improved and the upper limit of improvement has never yet been reached with any animal or plant.

Many plants, and some animals, have received little attention at the hands of the breeder, and have either become extinct or else exist among us with little or no improvement, except such as has naturally followed upon better general conditions. Conspicuous examples are clover and alfalfa among legumes; timothy and other non-grain producing grasses; asparagus, salsify and many other vegetables and most shade and ornamental trees.

Cats breed without attention and their variations do not, therefore, become fixed. The American bison was allowed to become extinct, not because he would not have become useful if carefully bred, but because he was too near like common cattle to repay the trouble of domestication. In the same way the common hen prevented the domestication of the prairie chicken, but fortunately no real rival stood in the way of that truly American bird, the turkey.

Thus has thremmatology lost much valuable material, but notwithstanding this there is yet at hand awaiting the attention of the master much that is full of undeveloped possibilities, and with the development of our knowledge of the principles underlying heredity and variation great improvements in methods of breeding may be confidently expected.

EUGENE DAVENPORT,
Dean of the College of Agriculture, University of Illinois.

THRESHER SHARK, or FOX SHARK, a well-known shark (*Alopias vulpes*), with a short conical snout and less formidable jaws than the white shark. The upper lobe of the tail fin is very elongated, being nearly equal in length to the rest of the body, and is used as a weapon by which this shark is able to kill or disable many fishes in a school, when he rushes into the midst of the crowd and lays about him. Tail included, the thresher attains a length of 13 feet. It inhabits the Atlantic and the Mediterranean.

THRESHING MACHINES. See FARM MACHINERY.

THRIFT, a stemless fleshy herb (*Statice armeria*) of the seacoasts of the world. It has tufted rosettes of linear leaves with no perceptible difference between blade and petiole and white, pink or purple five-parted flowers, with clawed petals. These blossoms are nearly or quite sessile in compact heads terminating an almost naked scape, and are subtended by brown, dry bracts, the two lowest reflexed, and partly united into a sheath. Thrift is otherwise known as sea-pink or lady's cushion, and is occasionally cultivated for flower-borders.

THRING, Edward, English schoolmaster and author: b. Alford, Somersetshire, 29 Nov. 1821; d. 22 Oct. 1887. He was educated at Eton and King's College, Cambridge, and after taking holy orders and serving as curate at Gloucester and elsewhere, in 1853 was appointed head master of Uppingham School. From an institution run down in efficiency and reputation he made it one of the healthiest, best equipped and flourishing public schools of England. No schoolmaster since Arnold was more successful in imprinting on the characters of his pupils a high ideal of duty as the great end of life. His own earnestness and honesty, his firm discipline and stern denunciation of cowardice and wrong gave character and reputation to the school. Among his published works are 'Thoughts on Life Science' (1869); 'The Theory and Practice of Teaching' (1883); 'Uppingham Sermons' (1886); 'Poems and Translations' (1887); and 'Uppingham and School Songs and Borth Lyrics' (1887). Consult Parkin, 'A Memory of Edward Thring' (1898); Skrine, 'Uppingham by the Sea' (1878).

THRIPS, a genus of minute insects, order *Hemiptera*, suborder *Homoptera*, closely allied to the *Aphides*. They are extremely agile and seem to leap rather than fly, whence the common name "leaf-hopper." They live on flowers, plants and under the bark of trees. *T. cerealium* is a common species, scarcely a line in length or in extent of wing, residing in the spathes and husks of cereals, especially wheat, to which it is most injurious.

THROAT, the front of the neck, including the structures below the chin and above the collarbone, and also, by an extended usage, the passage from the mouth to the stomach (fauces, pharynx and œsophagus), and the passage from the mouth to the lungs (larynx and trachea or windpipe), these being the passages for food and breath. The throat and its various structures are subject to many diseases, some of which are among the most difficult with which medicine has to deal. See NOSE AND THROAT, DISEASES OF.

THROMBOSIS, the formation or development of a thrombus (q.v.) in the heart, blood-vessels, lymphatics or other ducts. It is essentially the coagulation of fibrinogen and is usually induced by some condition which retards the flow of the blood, lymph, etc., such as roughness or other structural change in the lining membrane of a vessel or the presence of some foreign body or some alteration in the constitution of the blood, lymph, etc. In the heart and arteries it seldom occurs unless their lining membranes are roughened or their muscular tone is so much impaired that the blood is not forcibly and readily propelled onward. It is most frequent in veins, where the circulation is naturally slow, and it rarely occurs in capillaries. The thrombi formed may shrink and dry into leather-like masses or calcify, forming phleboliths (in veins) or soften and be absorbed or suppurate; or they may organize, as after the ligaturing of an artery. Some of the causes of thrombosis are: wounds and other injuries, inflammation (see PHLEBITIS; PHLEGMASIA), pressure on a vessel, failure of the propelling power of the heart, as in cases of marasmus and exhausting diseases and bacterial infection of the blood. The symptoms of thrombosis are those of the arrest of the circulation and differ according to the vessel affected. They include passive hyperæmia, venous dilatation, swelling of adjacent parts, gangrene, anasarca of an extremity, etc. The treatment varies according to the seat of the affection. See PATHOLOGY.

THROMBUS, *in anatomy*, a plug or clot formed in a vessel and partially or totally closing it. If it remains at its place of origin it is called a primary thrombus; if it has grown beyond its original limits it is a propagated thrombus; carried by the blood-current from a distant blood vessel and forced into a smaller one, obstructing the circulation, it becomes an embolus. A thrombus consists of coagulated fibrin entangling in its meshes red and white blood-corpuscles or of coagulated lymph, in lymphatics, and the term has been applied (milk thrombus), to an accumulation of curdled milk in a lactiferous tube. Thrombi are designated by various names according to their color, causation, shape, etc. Thus a white thrombus is one which contains no pigment or is composed chiefly of leucocytes; red, one colored by red blood; traumatic, one which results from an injury; infective, one occurring as the result of septic or bacterial poisoning; annular, one which has an opening through its centre, the circumference being attached to the wall of the vessel; and laminated or mixed, one whose substance is disposed in layers, which may differ in material. Thrombi, if small and remaining at the point of origin, may do little or no harm, but they are liable to be swept away and to become dangerous emboli. If they block up the lumen of a vessel they give rise to pain and swelling and to loss of function in parts of the body more or less remote. See THROMBOSIS.

THRONE, a chair of state or superior seat occupied by a sovereign, bishop or other dignitary. The modern throne is usually a decorated arm-chair of great size, raised on a dais and covered with a canopy, more or less ornamented. Anciently the throne was very elaborate; was made of marble, decorated with precious stones, and was frequently supported by pillars or figures representing beasts or men.

THROOP, Enos Thompson, American jurist, governor and diplomat: b. Johnstown, N. Y., 21 Aug. 1784; d. Auburn, N. Y., 1 Nov. 1874. He studied law at Albany and while there began a life-long friendship with Martin Van Buren. He took up practice of law at Auburn in 1807 where he soon entered public life as postmaster and county clerk. He was elected member of Congress in 1814 and in 1823 appointed circuit judge. It fell to his lot to try the Morgan abduction case and his service on the bench gave general satisfaction. Yielding to urgent request, he resigned to allow his name to be placed on the State ticket with Van Buren in 1828 and on the latter's becoming Secretary of State to President Jackson in March 1829, Throop became governor and was re-elected the following year. He served as naval officer at the port of New York, 1833–38, when he was sent by President Van Buren as chargé-d'affaires to the kingdom of the Two Sicilies (Naples). Relieved from this post on the election of Harrison, he spent two years at Paris and then returned home to private life. From 1847 to 1857 he brought a farm of 800 acres at Kalamazoo, Mich., to high cultivation. In the latter year he retired from activity to his former residence, Willowbrook, Auburn, N. Y., where with his nephew, E. T. Throop Martin, and family he shared the friendship of Secretary Seward and entertained such prominent visitors as Washington Irving, Jenny Lind and members of the diplomatic corps at Washington.

THROOP, Montgomery Hunt, American jurist: b. Auburn, N. Y., 26 Jan. 1827; d. Albany, N. Y., 11 Sept. 1892. He was educated at Hobart College in 1846; was admitted to the bar in 1848 and practised in Utica with his uncle, Ward Hunt (1854–56), and with Roscoe Conkling (1856–64). He removed to New York City in 1864; was appointed commissioner to revise the State statutes (1870); was chairman of the commission to revise the Code of Civil Procedure (1877) and removed to Albany in 1880 to devote himself to the publication of law books. He published 'The Future; a Political Essay' (1864); 'The Validity of Verbal Arguments' (1870); 'The New York Justices Manual' (1880); 'Digest of Decisions of the Supreme Judicial Court of Massachusetts' (1887); 'Revised Statutes of New York State' (1888).

THROOP, Pa., borough in Lackawanna County, near Scranton, and served by the New York, Ontario and Western and the Delaware, Lackawanna and Western railroads. Coal-mining is the chief industry and there is also a silk mill in operation. Pop. 5,133.

THROOP (troop) **POLYTECHNIC INSTITUTE,** located at Pasadena, Cal. It was founded in 1891 by Amos G. Throop to provide a liberal and practical education for both sexes. It is entirely non-sectarian, the charter providing that a majority of the trustees «shall not belong to any one religious denomination.» Its organization comprises five schools: (1) the grammar school; (2) the academy; (3) the commercial school; (4) the normal school; (5) the college. The academy offers three courses, classical, literary and scientific; and the college three courses, chemistry, electrical engineering and natural science, all leading to the degree of B.S. Some studies in each course are required, and some elective. Throughout the grammar and high school grades manual training is a regular part of the curriculum; instruction is given in wood carving, sloyd, carpentering, forging, machine-shop work, clay modeling, mechanical and free-hand drawing, sewing and domestic science. The commercial school provides a two years' course; and the normal school three two years' courses in manual training, domestic economy, free-hand drawing and designing, all of which include psychology, pedagogy and history of education. There is also a summer school of art and manual training, designed mainly for teachers; work done in this school is credited toward a normal diploma. The institute (1904) occupies two buildings, Polytechnic Hall and East Hall. The library in 1917 contained 7,000 volumes; and the Pasadena Public Library is also open to students. The productive funds amounted to $600,000, the students numbered 154 and the instructors 38.

THROSTLE, a Scotch name, like «mavis», for the British song-thrush (q.v.).

THRUSH, a bird of the passerine family *Turdidæ,* a family which contains some of the most familiar and attractive birds, and most of the best songsters of the world. They are characteristically but not entirely migratory. A few are only five or six inches in length, but the American robin (q.v.), eight inches is a typical form; and most of them are elegant in form and pleasingly but not gaudily colored. The thrushes are divisible into five subfamilies. The thrushes proper (*Turdinæ*) are represented by such familiar forms as the American bluebird, robin, woodthrush, shy northern hermit and olive-backed thrushes, noted for their richly melodious songs, the English blackbird, song-thrush, missel-thrush and fieldfare, besides the nightingale, robin-redbreast, hedgesparrow and many related forms in other parts of the world, most of which are elsewhere described under their names. Three American thrushes of this group call for brief mention, namely, the hermit thrush (*Hylocichla pallasii*), which is migrant through the Eastern States, breeding in the far north, and is noted for its grand song, which has been said to express «serene religious beatitude»; the olive-back or Swainson's thrush (*Hylocichla ustulata*), distinguished by the olive tint of its upper parts, and also a sweet-voiced emigrant; and the tawny thrush (see VEERY). In all of these the young are spotted, although the adults may be uniformly colored.

The second subfamily is composed of the genera *Myiodectes* and *Cichlopsis.* The third contains the Old World warblers (*Sylviinæ*), fantails, kinglets (qq.v.) and the like; the fourth (*Polioptilinæ*), the gnat-catchers (q.v.); and the fifth (*Miminæ*), the mocking-birds, thrashers (qq.v.) and related forms, many of which seem to imitate other birds, composing their own songs out of a medley of other notes, although the report of this tendency has usually been exaggerated; this last subfamily is by the most modern ornithologists separated from the thrushes and put with the wrens. Consult Evans, 'Birds' (New York 1901).

THRUSH, a form of parasitic stomatitis, due to the presence in the mouth of the thrush-fungus, white-moutte or sprue. (See MOUTH). The disease usually occurs in infants, but may appear later in life, even in old age, in association with some severe acute illness or some wasting disease, as pulmonary tuberculosis. The patches of thrush (technically aphthæ) are most commonly found on the dorsum and edges of the tongue, on the hard palate and on the inside of the lips and cheeks, and resemble curdled milk. Although the fungus may enter and even be formed in a healthy mouth, it will not flourish there. Inflammation or other abnormal condition of the mucous surface, and acid secretions, cause it to grow and develop. Thrush may be propagated by contagion, and in some institutions is at times almost endemic. It may be conveyed from one babe to another through an infected nipple of a nurse, or by means of infected spoons, feeding-bottles, teats, etc. Usually the mucous membrane of the mouth underlying the fungous patches is of a bright or livid red, but when the system of the patient is much deteriorated, and the mycelium has penetrated deeply, shallow ulcerations may result. Sometimes the fungus of thrush is found in diphtheritic membranes. Any doubt as to the nature of white patches in the mouth should be settled by a microscopic examination.

Of itself thrush is not dangerous, but it is usually significant of a deteriorated state of health. Occurring in apparently healthy children, it lasts but a few days; in children having gastro-intestinal catarrh and diarrhœa, and who are much debilitated, it may last for weeks, fresh spots appearing as others vanish. The redness and excoriation around the anus and adjacent skin of infants so affected is vulgarly regarded as an indication that the «thrush has run through the patient,» and if the mouth condition has improved it is considered a favorable sign. While the thrush-fungus has been found in the œsophagus, and even lower in the alimentary canal, there is no reason to believe that it is the cause of the redness and excoriation above referred to, which are rather due to a superficial dermatitis resulting from an excess of starchy food and a vitiated blood state.

Strict attention to diet is necessary in treatment; diminish the amount of sugar and starchy food, and give milk and lime-water. The mouth must be kept clean, and the chance of acidity diminished by dilute alkaline fluids, such as limewater or Vichy. A solution of borax and glycerine, or of sulphite of sodium, should be frequently sprayed upon the patches or applied with the finger, covered with soft cloth. The general health is to be maintained by tonics, hygienic measures and relief of debilitating ailments.

THRUSH, ***in veterinary surgery,*** a diseased condition of the frog of the horse's foot appearing as a severe and acute inflammation, which usually proceeds to ulceration, and which is accompanied by a fetid discharge. It is most frequently seen in horses of unsound constitution, and especially appears in stables where drainage and cleanliness are deficient. The best application for it is mineral tar. Calomel dressing is to be substituted for the tar in severe and intractable cases, and ulcerated and loose parts of the frog are to be carefully removed. Consult 'Report on Diseases of the Horse' (United States Bureau of Animal Industry, Washington 1911).

THRUST FAULT. See FAULT.

THRUSTON, Lucy Meacham, American novelist: b. King and Queen County, Va., 29 March 1862. She was graduated from the Maryland State Normal School in 1880, and was married to Julius Thruston in 1887. She has published 'Mistress Brent' (1901); 'A Girl of Virginia' (1902); 'Jack and His Island' (1902); 'Where the Tide Comes In' (1904); 'Called to the Field' (1906); 'Jenifer' (1907); 'The Heavens of the Unexpected' (1910).

THUCYDIDES, thū-sĭd'ĭ-dēz, Greek historian: b. Attica, about 460 B.C.; d. about 400 B.C. His father's name was Olorus, his mother's Hegesipyle. He possessed gold mines in Thrace opposite the island of Thasos, and was in consequence one of the richest and most influential men in Thrace. In 431 B.C. the Peloponnesian War, which forms the subject of his work, was begun. In 430 the plague broke out in Athens. Thucydides took it, but recovered, and in 424 B.C. commanded a squadron of seven ships at Thasos. The Spartan general Brasidas besieged Amphipolis, and Eucles, who commanded in that important post, sent to Thucydides for aid. Thucydides made all haste in preparing to answer the summons, and seems to have used his private means to forward his equipment, but Brasidas, apprehensive of the approaching relief, offered favorable terms to Eucles, which were accepted, and Thucydides only arrived the day after the surrender. Yet he was in time to save Eion from falling into the hands of the enemies. Whether this transaction led to the banishment of Thucydides, or whether he exiled himself to escape death as its probable consequence, is not known; but from this time he became an exile, and the duration of his exile, according to his own account, was 20 years. Before the conclusion of this term the war terminated (404 B.C.), and all political exiles were permitted to return. Thucydides returned to Athens in the following year; and met a violent death a year or two later, but at what exact time, and whether in Thrace or Athens, is not known. During his exile he remained close to the theatre of the war, of which he was a diligent observer, and as he could not remain in the Athenian dominion he may have passed this period of his life, or the greater part of it, within the domains of the Spartan alliance. It is also probable that he visited Sicily and southern Italy. His history consists of eight books, the last of which differs from the others in containing none of the political speeches which form so striking a feature of the rest, and is also generally supposed to be inferior to them in style. Hence it has been thought by various critics to be the work of a different author, of Xenophon, of Theopompus, or of a daughter of Thucydides; but it is more probable that it is the author's own without his final revision. The history is incomplete, the 8th book stopping abruptly in the middle of the 21st year of the war. As a historian Thucydides holds the foremost place. He was painstaking and indefatigable in collecting and sifting facts, brief and terse in narrating them. His style is full of dignity and replete with condensed meaning. It is, however, sometimes harsh and obscure from over-condensation. He is unsurpassed in the power of analyzing character and action, of tracing events to their causes, of appreciating the motives of individual agents and of combining in their just relations all the threads of the tangled web of history, and his work has been styled the «Statesman's Handbook.» It is to the superiority and impartiality of his judgment that he owed the power of producing a work which should be, as he himself said, a possession for posterity. Among the most valuable editions of Thucydides are those of Bekker (3 vols., Berlin 1821); Classen (8 vols., Berlin 1862–78); Poppo (1821–38); and Stahl (1873–74). There are English translations by Dale (Bohn Classical Library), and Benjamin Jowett (with introduction and historical notes, 2 vols., London 1881; Boston 1883). Consult Bury, J. B., 'Ancient Greek Historians' (New York 1909); Cornford, F. M., 'Thucydides Mythohistoricus' (ib. 1907); Grundy, G. B., 'Thucydides and the History of his Age' (London 1911), also standard histories of Greece.

THUGS, or **THAGS,** a vast fraternity of murderers that formerly existed in India until the British government undertook to crush it out in the early '30 of the 19th century. The practitioners of Thuggee claimed to be a religious sect devoted to the goddess Kali, or Deve or Bhowanee, as she was indifferently called. Composed of Mohammedans and Hindus — mostly the former — the Thugs combined robbery with assassination; they strangled their victims and interred the bodies. They operated in companies of from two to 200, with scouts, «inveiglers,» apprentices and professional stranglers. Some believe that the organization dates back to the days of Alexander or even Xerxes; but more probably it originated with the wild camp-followers and plunderers who followed the Moslem armies of conquest. The craft was hereditary; its followers were divided into Burkas, or persons fully instructed in the art, and Kuboolas, or novices. They were first employed as scouts, then as Sextons, then as shumseeas or holders of hands, and lastly as Bhurtotes or Burkas. The novice became a cheyla or disciple to a high priest of the cult, a gooroo, who conferred the rank or ordination upon the qualified student. The Thugs traveled along the roads as traders or pilgrims, or as Sepoys seeking or returning from service. Sometimes one of their number figured as a rajah with a large retinue of followers. Scouts gathered information about travelers, and «inveiglers» wormed themselves into the confidence of their intended victims. The crimes were usually committed when all were encamped, and two Thugs were appointed to each person to be murdered. Occasions have been known where as many as 60 persons were strangled in one party. The rules of the Thugs forbade the killing of women, fakirs, musicians, dancers, sweepers, oil-vendors, carpenters, blacksmiths, maimed and leprous persons, and Ganges water-carriers. Despite the prohibitions, however, women were frequently strangled. They did not murder white people on account of investigations accompanied by punishment that would surely result. This circumstance accounts for the fact that, although Thuggee was known to exist in the 16th century, it was not partially unravelled till about 1812. At that time there were at least 10,000 Thugs plying their hideous trade; some 30,000 natives vanished annually, leaving no trace behind. In the midst of this reign of terror a savior suddenly appeared in the person of Captain (afterward Maj.-Gen. Sir William) Sleeman, a junior official in the service of the East India Company. He began Thug-hunting in 1830, with the title of «General Superintendent of Operations against Thuggee,» conferred on him by Lord William Bentinck. An Irishman, Molony, had captured a roving band of 115 Thugs in 1823, while another gang was seized in 1826. Within five years Sleeman had thousands of them in prison; 20 Thugs confessed to him that they had participated in 5,120 murders; one, Buhram, who had been a strangler for 40 years, had 931 murders to his discredit; Ramzan had 604, and Futty Khan 508. Sleeman broke the back of the organization. Up to October 1835 no fewer than 1,562 Thugs had been committed; 382 were hanged and 986 transported or imprisoned for life. As a sect they no longer exist, though isolated cases still occur. Consult the annual 'Reports on the working of the Thagi and Dakaiti Department of the Indian Government,' from 1860; 'Ramaseeana: a Vocabulary of the peculiar language used by the Thugs' (Calcutta 1836); *Quarterly Review,* January 1857 and October 1901; Hutton's 'Thugs and Dacoits' (London 1857); Meadows-Taylor, 'Confessions of a Thug' (London 1879); Sleeman, Sir W., 'The Thugs or Phansigars of India' (Philadelphia 1839); and the same author's 'Report on the Depredations committed by the Thug Gangs of Upper and Central India' (Calcutta 1840) and 'Rambles and Recollections of an Indian Official' (London 1844; new ed., August 1915); Sue, Eugene, 'The Wandering Jew' (1844–45).

HENRI F. KLEIN,
Editorial Staff of The Americana.

THULE, thū'lē (Greek, Θούλη), a name given by the ancients to an island or group of islands in the ocean to the northwest of Europe. It was thought to be the northernmost inhabited region of the earth. It is believed to have been the Shetland Islands, though some have identified it with Iceland, and others with both Norway and Jutland. The term «ultima Thule» was used by the Romans whenever reference was made to the farthest distant unknown land.

THULITE, a rose-pink variety of the mineral xoisite (q.v.).

THULSTRUP, Thure de, American artist: b. Sweden, 1848. Graduated from the National Military Academy at Stockholm, he entered the Swedish army in 1865; served in the Franco-Prussian War and was present at both battles of Lyons. He served also in Algeria as an officer in the French army. After studying drawing in Paris he went to Canada, later coming to the United States. In 1872 he joined the staff of the *Graphic* as illustrator; was connected with the Frank Leslie publishing house in the same capacity from 1876 to 1880; when he entered the employ of Harper Brothers. He is especially well known as a military and historical illustrator.

THUMANN, too'män, **Paul,** German painter: b. Tschacksdorf, Brandenburg, 5 Oct. 1834; d. 1908. He was a student in the Academy of Berlin from 1853 to 1855 and subsequently worked under Julius Hubner in Dresden till the year 1860. At Weimar he studied with Ferdinand Pauwels and in 1866 was appointed professor in the art school of that city. From 1875 to 1887 he filled the duties of professor in the Art Academy of Berlin. He was mainly occupied in the illustration of Auerbach's 'Kalender'; Goethe's 'Dichtung und Wahrheit'; Tennyson's 'Enoch Arden'; Chamisso's works; and Heine's 'Buch der Lieder,' etc. His success in this work was due to the powerful drawing, thoughtfulness, and genuine feeling which characterized his style; yet latterly he lapsed into a certain sickly sentimentality and frivolity of treatment which injured the reputation won by his early productions. Among his paintings the best are five canvases which illustrate the life of Luther, executed for the castle of Wartburg; 'The Wedding of Luther'; 'The Return of Hermann from the Battle of Teutoburg Forest'; and 'The Three Fates.'

THUN, toon, Switzerland, (1) a lake in the canton of Bern, 10 miles long by two miles broad. Its surface is over 1,800 feet above sea-level and its greatest depth 712 feet. It forms the outlet of the Aar, which leaves it at the northwest. The lake is enclosed by gentle slopes, covered with villas and orchards, except beyond Sigriswyl, where the north bank is more precipitous. The scenery is idyllic. Fish are plentiful, especially eels, carp, pike, etc. Steamers run from Thun to Interlaken, and an old road follows the coast toward the south, a new one toward the north. The important towns along the banks are Oberhofen (health resort), Spiez and Simmerthal. The first steamer on the lake was launched in 1835. (2) The town of Thun in the canton of Bern is one mile distant, and is the station for travelers touring the Bernese Oberland. It is the principal military arsenal of Switzerland and here is located a military institution for army officers. The noteworthy buildings are the Gothic church and the old 12th century castle. The manufacture of bricks and pottery forms the main industry. Thun was the capital of the canton of Oberland of the Helvetian Republic (1798–1802). Pop. 7,885.

THUNDER. See LIGHTNING AND LIGHTNING-RODS.

THUNDER-BIRD, an imaginary bird occurring in the mythology of races of low culture, and personifying thunder or its cause. Among the Caribs, Brazilians, Algonkins and various other North American Indians and among the Karens of Siam, the South African Bechuanas and Basutos, and other aborigines, there are legends of a flapping or flashing thunder-bird, which seem to translate into myth the thought of thunder and lightning descending from the upper regions of the air, the home of the eagle and the vulture.

THUNDER CLOUD, Mohawk Indian chief and army scout: b. Caughnioga, Canada, about 1856; d. Rochester, N. Y., 1916. He became noted during the Indian troubles (1872–76) and rendered valuable assistance to the United States army, being one of those who helped to capture Chief Red Cloud. In civil life he became celebrated as an artist's model and posed for the leading painters of Indians and Indian scenes. Frederick Remington used him frequently and he appears in various historical groups in the capitol at Saint Paul, Minn., the work of Millet and others. His head appears on the gold coin of the United States for which Victor Brenner selected his profile.

THUNDERBOLT, The, a comedy in four acts, by Sir Arthur Wing Pinero, represents the mature work of one of the most skilful of contemporary English dramatists. In it he discards most of the theatrical conventions which constitute the common stock in trade of the playwright's craft and which he knows how to use with consummate ease and dexterity. He himself modestly describes 'The Thunderbolt' as «an episode in the history of a provincial family.» We are introduced in the first act into a family conclave of the Mortimores. Edward, the only member who has achieved wealth, lies dead upstairs. He was a bachelor and although he had been estranged from his brothers and sister for many years, they are his «next of kin» and presumably his heirs, for, to their delighted surprise, he has apparently left no will nor made any provision whatever for the young woman who is known to be his daughter and whom he has educated and supported lavishly and affectionately. The reactions of the various members of the family to this situation as it develops are portrayed with a ruthless truth and simplicity which remind one rather of Balzac than of the author of 'Sweet Lavender,' 'The Magistrate' and 'The Second Mrs. Tanqueray.' One feels the influence of the conversational play of Shaw and Granville Barker but in 'The Thunderbolt' it is real talk of quite ordinary people, always forwarding the movement of the drama, never halting it for philosophical discussion or brilliant monologue. Pinero is so enamored of his new realistic method that he sacrifices to it the opportunity of an effective «curtain» in the third act. The family is again in council and the thunderbolt has fallen; there *was* a will leaving everything to the daughter, Helen. Thaddeus, having just been forced to confess that it was his wife, not himself, who had found and destroyed this will, flings out of the room with a frantic but futile appeal to the family and the lawyers: «Oh, my God, let me get her away! . . . Don't you harm a hair of her head! Don't you touch her! She's been a good wife to me!» Instead of ending the scene on this poignant note, Pinero makes us linger to watch the exasperated family quarrel and lament over the money they see slipping through their greedy fingers. But greedy and selfish and petty as they are, they are very human, and James' frank statement in the last act of what the money really means to them reconciles one to the solution by which they all get a share, although Helen's magnanimity is perhaps the least natural thing in the play. She is not a very appealing heroine and all the other characters are people one would avoid if possible in real life. There is no love interest, no sex problem, no fun, and but little action. In view of the lack of these elements of popular appeal it is not surprising that 'The Thunderbolt' has not been one of Pinero's conspicuous successes on the stage but to the real lover of the drama and to the student of life, it is his most important play. It was first

produced in London in 1908 and was presented at the New Theatre, New York, in 1910.
GRACE R. ROBINSON.

THUNDERING LEGION. See LEGION, THE THUNDERING.

THÜNEN, tu'nen, **Johann Heinrich von,** German economist: b. Oldenburg, 1783; d. 1850. He received a thorough education in agriculture and also studied at Göttingen. In 1810 he bought an estate in Mecklenburg-Schwerin, which he developed into a model farm. He is known now principally for the economic views expressed in 'Der isolirte Staat in Beziehung auf Landwirtschaft und Nationalökonomie' (3 vols., 1826–63). In this work he sets down simple premises in regard to wages and land, production, markets, etc. His law of wages has found favor among more recent economists. Consult Palgrave, 'Dictionary of Political Economy' (3 vols., London 1899); and Schumacher, H., 'J. H. von Thünen, ein Forscherleben' (2d ed., Rostock 1883).

THURBER, George, American naturalist and writer: b. Providence, R. I., 2 Sept. 1821; d. Passaic, N. J., 2 April 1890. He was educated at the classical and engineering school at Providence; he became a pharmacist and a lecturer on chemistry, finally securing an appointment (1850) with the commission to settle the boundary between the United States and Mexico. He made an important collection of plants and on his return to Providence was given the degree of A.M. by Brown University. He secured an appointment in the Assay Office in New York, lectured on botany in Cooper Institute and on botany and materia medica in The New York College of Pharmacy. Later he occupied the chair of botany and horticulture in the Michigan College of Agriculture but returned again to New York and to lecture at the College of Pharmacy and finally became editor of the *American Agriculturist* for 24 years. In 1880 he visited Europe. He was life member of the Royal Horticultural Society, life member of the American Pomological Society, an active member of the New York Academy of Sciences and corresponding member of the Philadelphia Academy. His collection of Western plants is in the Gray Herbarium at Harvard.

THURGAU, toor'gow, Switzerland, a canton at the northeast, with an area of 381 square miles. Unlike most Swiss cantons it has no high elevations, but a diversified surface, most of which is productive. It belongs to the Rhine Basin and is chiefly watered by the Thur and affluents. There are extensive forests, and the arable lands yield a limited amount of grain and potatoes and grapes — fruit is abundant. Stock-raising and dairying are also carried on. Manufactures consist of linen and hempen cloth, ribbons, lace, hosiery, muslin, buttons and wooden articles. There is considerable trade, owing partly to Lake Constance and the Rhine on its borders. The canton was organized in 1798, although it had been in possession of the Swiss from 1460. For nearly 200 years prior to that time it belonged to the house of Hapsburg. The capital is Fravenfeld. Pop. of canton 140,540. See SWITZERLAND.

THURIBLE. See CENSER.

THURIFER, in Roman Catholic Church services, the attendant at High Mass, Solemn Vespers and Benediction, who uses the thurible, either by simply waving it to and fro or for incensing the clergy, choir and congregation, and who at certain times presents it to the officiating priest that he may incense the altar or the Host. Strictly speaking, the office of thurifer belongs to the acolyte, the highest of the four Minor Orders, but all the functions of the acolyte are now freely performed by laymen.

THURINGERWALD, tü'ring-ĕr-vält, or **FOREST OF THURINGIA,** Germany, a series of mountain ranges centrally located, extending from the Werra near Eisenach southward as far as the valley of the Rodach. The ramifications toward the southeast and the west connect it with the Frankenwald and the Rhön Mountains. The highest elevations are found in the Grosser Beerberg (3,228 feet), and the Schneekopf (3,201 feet), west of Zelle. The entire mountain range is covered to its summit with evergreens and leafy trees and its slopes and valleys present charming landscape and views. The principal streams are the Gera, Wipper, Ilm and Schwarza, flowing into the Unstrut and Saale; the Rodach, Haslach, Steinach and Itz; and the Werra with its affluents — the Hörsel and Leine. There are rich deposits of iron, copper, cobalt, lead and, in the neighborhood of Friedrichroda, alabaster. The valleys and slopes are the scene of an active industry, including porcelain factories, glass-works, wooden manufactures, especially toys, slate, meerschaum and other pipes, firearms and celebrated pottery. Thüringerwald is much frequented by tourists, and the transportation and other facilities are unsurpassed.

THURINGIA, Germany, territorial name still borne by that part of Upper Saxony generally bounded by the Werra, the Saale and the Harz Mountains, though it has no longer any political significance. It was once a much more extensive territory. The name was derived from the Thuringian tribe which occupied it in the 5th century. Much of its area is covered by the Thüringerwald (q.v.). Erfurt is the largest city. The region has had a chequered history, falling in turn to Thuringian, Frank and Carlovingian. It was in turn a kingdom, duchy and mark. (See SAXE-WEIMAR). Consult Devrient, Ernst, 'Thüringische Geschichte' (Leipzig 1907); Knockenhauer, Thomas, 'Geschichte Thüringens in der karolingischen und sächsischen Zeit' (Gotha 1863); 'Geschichte Thüringens zur Zeit des ersten Landgrafenhauses' (ib. 1871).

THURLOE, John, English statesman: b. Essex County, 12 June 1616; d. London, 21 Feb. 1668. He studied law, was admitted to Lincoln's Inn in 1647 and was appointed to a government post in 1648. He took no part in the political events leading to the king's death. On 29 March 1652 he was appointed Secretary to the Council of State under Cromwell; and was also given control of the intelligence department, which duties he performed so remarkably well that it was said that the enemies of the Protector made no move without detection by Thurloe or his assistants. He stood high in Cromwell's regard and enjoyed his confidence to a greater extent than any other adviser. He served in the Parliaments of 1654 and 1656, and was reappointed Secretary of Cromwell's Council of State in 1657. He became chancellor of Glasgow University in 1658. He supported Richard Cromwell's succession after the death of Oliver Cromwell, sat in the Parliament of 1659, continued prominent in government affairs and in 1660 was reappointed Secretary of the Council of State. After the Restoration he was arrested on a charge of high treason 15 May 1660, but was freed subject to attending the secretaries of state whenever they should require his services. His correspondence is in the Bodleian Library, Oxford, and is an important source of historical information. A part of it was published with a biographical sketch by T. Birch (1742).

THURLOW, thėr'lō, **Edward**, Lord, English lord-chancellor: b. Bracon Ash, Norfolk, 9 Dec. 1731; d. Brighton, Sussex, 12 Sept. 1806. He was educated at Caius College, Cambridge, subsequently entered the Middle Temple and in 1754 was called to the bar. In 1761 he attained the rank of king's counsel, and was employed to prepare the evidence for the appeal in the great Douglas cause, which, however, did not come on for hearing in the House of Lords until 1769. In 1768 he was returned as member of Parliament for Tamworth, and became a constant supporter of Lord North's administration. In 1770 he was made solicitor-general, and Attorney-General in 1771. In 1778 he was appointed lord-chancellor, and raised to the peerage as Baron Thurlow. The personal favor of the king retained him in office during the Rockingham administration, whose measures he actively opposed, but he was compelled to resign on the dissolution of the ministry in 1783. He was still considered the confidential adviser of the king, and on the dissolution of the coalition ministry at the close of the year the great seal was restored to him by Pitt. In 1788 the king's illness rendered it necessary to consider the contingency of a regency and Pitt suspected Thurlow of intriguing with the Prince of Wales. Thurlow then began publicly to oppose the measures of his colleagues, particularly Pitt's scheme for maintaining the sinking-fund, in the House of Lords, whereupon Pitt demanded his dismissal, to which the king at once agreed. Consult Campbell, 'Lives of the Chancellors'; Foss, 'Judges of England' (London 1848-64).

THURMAN, thėr'man, **Allen Granbery**, American lawyer and politician: b. Lynchburg, Va., 13 Nov. 1813; d. Columbus, Ohio, 12 Dec. 1895. He was brought, in childhood, to Chillicothe, Ohio, and there received an academic education. After teaching for a time he studied law in the office of his uncle, William Allen (q.v.); in 1835 was admitted to the bar and forming a partnership with his uncle soon attained success as a practising lawyer. At the same time that he began his legal career he became active in politics as a member of the Democratic party, but held no political office until 1844, when he was elected to Congress. He was one of the earnest supporters of the administration in the conduct of the Mexican War; though a Democrat and opposed to any change in the Missouri Compromise (q.v.), he, with the most of the Northern Democrats, voted for the Wilmot Proviso (q.v.), and replied to Southern criticism of this act in a speech stating, forcibly, the reasons of the North for opposing the extension of slave territory. At the close of his Congressional term he resumed the practice of law, and in 1851 was elected one of the judges of the Ohio Supreme Court; here his learned and able decisions won him wide reputation as a jurist. When his term of office expired in 1856 he again took up the practice of his profession, this time in Columbus. He took no active part in politics until 1867, when he was nominated by the Democrats as governor of Ohio; he conductd a vigorous campaign, and though defeated by a small plurality, the Democratic party carried the legislature. In the next year he was elected to the United States Senate and re-elected in 1874. His ability in debate won him immediate recognition, and he was appointed a member of the Judiciary Committee, and became the leader of his party in the Senate; during his last term he was elected president pro tem. He favored a liberal policy of reconstruction, introduced the so-called Thurman Bill compelling the Pacific Railroad to comply with the conditions of their franchise, and succeeded in effecting the passage of this bill against a powerful opposition. In 1876 he was a member of the Electoral Commission (q.v.), and steadfastly supported the claims of Tilden. He was a candidate for the Democratic Presidential nomination in 1876, 1880 and 1884; in 1881 he was appointed a member of the Paris Monetary Conference. In 1888 he was the Democratic nominee for Vice-President and took active part in the campaign; after the defeat of his party in that year, he retired from political life. Consult Hensel and Parker, 'Lives and Public Services of Grover Cleveland and Allen G. Thurman' (Philadelphia 1892).

THURN, Henry Matthias, Count, Bohemian Protestant military leader: b. 1580; 28 Jan. 1640. He served in the Turkish War and for his services was made Burgrave of Karlstein, Bohemia, by Emperor Rudolph I; he was deprived of his estates, however, after he was named one of the Thirty Defenders of the Faith by the Bohemian estates. He was the leader of the Bohemian Protestant insurgents at the beginning of the Thirty Years' War in 1618; invaded Austria and unsuccessfully besieged Vienna in 1619; and was decisively defeated at White Hill in 1620. He afterward served in the Swedish army; and in 1632 fought under Wallenstein at the defeat of Lützen.

THURSDAY, the fifth day of the week, so called from the old Teutonic god of thunder, Thor, the northern Jupiter. The German name Donnerstag is of similar origin; and Thor, Donner, are equivalent to English thunder. Ascension-day is often called Holy Thursday.

THURSDAY ISLAND, Queensland, a small island in Torres Strait, 30 miles from Cape York. It has an excellent harbor, Port Kennedy, which is a port of call and trade depot. Pop. about 2,000.

THURSTON, John Mellen, American statesman; b. Montpelier, Vt., 21 Aug 1847; d. Omaha, Neb., 9 Aug. 1916. His parents took him to Wisconsin, where he was educated in the public schools. He received his education at Wayland Academy at Beaver Dam, Wis., and in 1869 was admitted to the bar. Soon afterward he went to Omaha, Neb., where he spent most of his life. About 1873 he was a member of the city council and was city attorney in 1874–77. In 1875 he was elected to the Nebraska legislature as a Republican and was a presidential elector in 1880. Soon afterward he became counsel for the Union Pacific Railroad. In 1893 the Republican caucus nominated him for United States Senator, but he did not go to Washington until 1895. He remained until 1901. He seconded the nomination of William McKinley for President in 1896, vacating the chair at that convention to do it. From 1889 to 1891 he was president of the Presidential Republican League. In 1901 he became a commissioner of the Saint Louis Exposition.

THURSTON, Robert Henry, American engineer and educator: b. Providence, R. I., 25 Oct. 1839; d. Ithaca, N. Y., 25 Oct. 1903. He was graduated from Brown University in 1859, and received his mechanical training in his father's engine-building shops. In 1861 he joined the engineer corps of the navy, served during the Civil War, was twice promoted, and in 1865 was appointed assistant professor of natural philosophy at the United States Naval Academy. In 1872 he resigned his commission in the navy, and accepted the professorship of mechanical engineering at the Stevens Institute of Technology. He was appointed a member of the United States scientific commission to the Vienna Exhibition in 1873; and in 1885 became the director of Sibley College, the engineering department of Cornell University, and university professor of mechanical engineering. The excellence of the Sibley College curriculum is largely due to his ability as an organizer, and his administration made the college one of the foremost engineering schools of the country. As an inventor he was known for his magnesium burning lamps, army and navy signal apparatus, various forms of testing machines for iron and other metals, and an engine-governor and other improvements on the steam-engine. In scientific research his most noteworthy work was done in investigating the commercial economy of the steam-engine, and in determining the useful qualities of various alloys. His contributions to engineering and scientific literature are also of value, being marked by a clearness of statement unusual in technical writing. The more important of his publications are 'Materials of Engineering' (3 vols., 1884; new ed., 1907–10); 'Manual of the Steam Engine' (1890–1902); 'Manual of Steam Boilers' (1888–1901); 'Engine and Boiler Trials' (1890–1903); 'History of the Steam Engine' (1878–1902). Others are 'Friction and Lubrication' (1884); 'Materials of Construction' (1890–1900); 'Stationary Steam Engines' (1885); 'Friction and Lost Work in Machinery and Mill Work' (1885–1903); 'Heat as a Form of Energy' (1890); 'Life of Robert Fulton' (1891) and numerous scientific papers. Consult Durand, W. F., 'Robert Henry Thurston' (Washington 1904).

THUSNELDA, wife of Arminius (q.v.), chief of the Cherusci, a German tribe which drove the Romans from the Elbe and the Weser in 9 A.D. In 14 A.D. the Roman legions again penetrated the German interior, and Thusnelda was taken captive to Rome by the Roman conqueror, Germanicus Cæsar (q.v.).

THWAITES, thwāts, **Reuben Gold,** American historian and editor: b. Dorchester, Mass., 15 May 1853; d. 1913. He was educated at the high school of his native town and in 1874–75 took a postgraduate course at Yale. From 1876 to 1886 he was managing editor of the Wisconsin *State Journal.* He published 'Down Historic Waterways' (1888; rev. ed. 1902); 'The Story of Wisconsin' (1890); 'The Colonies, 1492–1750' (1891); 'Afloat on the Ohio' (1897); 'Daniel Boone' (1902); 'Father Marquette' (1902); 'Brief History of Rocky Mountain Exploration' (1904); 'France in America' (1905); 'School History of the United States' (1912). He also edited 'The Jesuit Relations' (73 vols. 1896–1901); 'Original Journals of Lewis and Clark' (7 vols., 1905); 'Early Western Travels, 1748–1846' (32 vols., 1904–07), and other works. Consult Turner, F. J., 'Reuben Gold Thwaites' (Madison, Wis., 1914).

THWING, twĭng, **Charles Franklin,** American college president: b. New Sharon, Me., 9 Nov. 1853. He was graduated at Harvard in 1876, and at Andover Theological Seminary in 1879; received the honorary degees of S.T.D., from Chicago Theological Seminary in 1889, LL.D., from Marietta College in 1894, from Illinois College in 1894, from Waynesburgh College in 1901, from Washington and Jefferson College in 1902, and from Kenyon College in 1910; was ordained Congregational minister in 1879; was pastor of North Avenue Congregational Church in Cambridge, Mass., 1879–86, of Plymouth Church in Minneapolis, 1886–90, and president of Western Reserve University and Adelbert College since 1890. He is associate editor of *Bibliotheca Sacra* since 1884, secretary of the Carnegie Foundation for the Advancement of Teaching, and president of the Intercollegiate Peace Association. President Thwing is the author of 'American Colleges: Their Students and Work' (1878); 'The Reading of Books' (1883); 'The Working Church' (1894); 'Within College Walls' (1894); 'The College Woman' (1894); 'The American College in American Life' (1900); 'College Administration' (1900); 'The Best Life' (1900); 'The Choice of a College' (1901); 'God in His World' (1902); 'The Youth's Dream of Life' (1902); 'If I were a College Student' (1902); 'A Liberal Education and a Liberal Faith' (1903); 'College Training and the Business Man' (1906); 'Higher Education in America, A History' (1906); 'Education in the Far East' (1909); 'History of Education in the United States since the Civil War' (1910); 'Universities of the World' (1911); 'Letters from a Father to His Son entering College' (1912); 'Letters from a Father to His Daughter entering College' (1913); 'The Co-Ordinate System in the Higher Education' (1913); 'The Family: An Historical and Social Study' (1886 in collaboration with Carrie Butler Thwing, revised 1913); 'Education according to Some Modern Masters' (1916) and contributions to magazines.

THYESTES, thī-ĕs'tēz. See ATREUS.

THYLACINE, an Anglicization of the generic term *Thylacinus* given to the predatory marsupial called Tasmanian or zebra wolf, and described under DASYURE (q.v.).

THYME, one of the species of the labiate genus *Thymus,* small, shrubby, perennial herbs of the Old World, cultivated on account of their aromatic foliage as flavoring herbs, or for ornament. *T. vulgaris,* an erect, or somewhat decumbent plant, from one to two feet high, has sessile linear-lanceolate leaves with revolute margins. The pale-lilac flowers are small, and in interrupted spikes at the ends of the branches. Thyme has a very strong and pungent odor, and was formerly employed for seasoning. It is a favorite food of bees, and that of the Grecian hills produced the famous honey of Mount Hymettus. Another thyme, sometimes grown as a culinary herb, but more often to cover rock-work and waste places, is the creeping thyme or mother-of-thyme (*T. serpylliformis*). Its internodes are short, so that the plant is very leafy, and it grows in dense, broad tufts. One of its varieties (*citriodorus*), is the lemon-scented thyme. Oil of thyme is distilled from these plants, especially in France, where they are very abundant, and may be used in perfumery instead of the oil of origanum, and is of utility in veterinary practice. Thymol is a solid, acrid stearoptene obtained from this oil, and is used, chiefly externally in alcoholic solution, for a stimulant and powerful antiseptic in the treatment of wounds and sores. Other labiates called thyme, from their aroma, are *Calamintha acinos,* and *C. nepeta,* the basil thyme, and *C. clinopodium,* the horse-thyme. The cat-thyme is the herb-mastic, or *Teucrium marum,* a powerful sternutatory, useful for its scent. Virginian thyme is *Koellia virginiana.*

THYME OIL, a volatile oil obtained by distilling the leaves and flowering tops of *Thymus vulgaris,* or garden thyme, with water. Colorless when pure, sparingly soluble in water, easily so in alcohol. It contains two hydrocarbons pinene, $C_{10}H_{16}$, and cymene, $C_{10}H_{14}$, as well as a phenol-like body thymol. Used in liniments and dressings as a stimulant and antiseptic.

THYMOL, *in chemistry,* $C_{10}H_{14}O$, a colorless crystalline compound obtained from the oil of thyme, horse mint, etc. Often called thyme camphor. Its chemical nature is analogous to that of phenol, or carbolic acid, though it has but little of the caustic properties of that body. It crystallizes in plates, is almost insoluble in water, soluble in alcohol, melts at 44° C., and is very easily attacked by many chemical agents. It has a very strong odor and is used as an antiseptic and disinfectant. Iodine and caustic potash convert it into di-iodo-thymol, which is the well-known antiseptic aristol.

THYMUS GLAND, one of the ductless glands, existing as a temporary organ, developed to its full size about the end of the second year of life and decreasing in size after that period. At puberty it almost or wholly disappears. At its full development it appears to consist of two lobes or halves, situated in the middle line, and placed partly in the neck, extending from the cartilage of the fourth rib upward as high as the inferior edge or border of the thyroid gland (q.v.). It is covered in front by the breastbone, and by the sternohyoid and sternothyroid muscles. It rests upon the pericardium or heartsac, and lies on the neck on the front and sides of the trachea or windpipe. This gland is of a pink-gray color, exhibits a lobulated appearance, and is of soft consistence. Its weight at birth is about half an ounce. Its microscopic structure exhibits a composition of lobules, each lobule being formed of regularly disposed masses of what is termed lymphoid tissue, consisting of a meshwork of exceedingly delicate connective tissue, the meshes being crowded with round cells identical with the white corpuscles of the blood and lymph corpuscles. The functions of this gland are still undetermined. It is placed in the same category as the thyroid gland and spleen; and the most probable theory as to its use is that which assigns to it the work of elaborating the elements of the blood, especially in the earlier years of life. It is generally believed to exert a strong influence on growth and development. It is employed in organotherapy (q.v.). The well-known 'sweatbread' is the thymus gland of a calf or lamb.

THYRIDOPTERYX, a genus of foliage-destroying insects. See BAGWORM.

THYROID GLAND, a structure having no outlet or duct, and classified with the spleen, thymus gland and suprarenal capsules under the general name of ductless glands. In man the thyroid gland is situated at the upper part of the trachea or windpipe and consists of two halves or lobes, placed one on each side of the windpipe, and united by a narrow bridge of substance — the isthmus of the gland. It is covered in front by the muscles of the neck and its sides lie in contact with the common carotid artery. Its under surfaces embrace the windpipe and larynx. This gland is of a reddish color. It is larger in women than in men, and weighs, on an average, about one and one-half ounces. It may become enormously enlarged, as in goitre. Its structure consists of numerous small shut sacs, surrounded by a network of capillary blood-vessels. Each vesicle or shut sac is lined internally by a single layer of columnar cells, and is filled with a glairy mucoid substance. The blood-vessels of the gland are derived from the superior and inferior thyroid arteries and its nerves come from the pneumogastric and sympathetic trunks. The use of this gland is not quite clear, but is generally held to be the production of a secretion which has a great influence on alimentation. Its business is connected with the maintenance of a proper quality of blood, either by the removal of certain effete substances from the blood, or by the addition of certain elements to it. Its complete extirpation or atrophy is attended with disease. The thyroid gland of the sheep is used in the treatment of myxœdema, the complication resulting from the loss of function of the gland.

THYROID GLAND, Diseases of. Several varieties of enlargement have been noticed in the thyroid and are generally grouped under the general term goitre (q.v.). Myxœdema is the condition resulting when the gland ceases to function either because of atrophy or of the excision of the organ. The thyroid gland of the sheep is used in the preparation of an extract which is efficacious in the relief of this condition. See CRETINISM; SECRETIONS, INTERNAL; THYROID GLAND.

THYRSE, thẽrs, a form of inflorescence consisting of a compact panicle in which the middle pedicels are the longest, giving the whole an ovate shape. The primary pedicels are centripetal, and the secondary centrifugal. The horse-chestnut and lilac furnish examples.

THYSANURA, an order of neuropteroid insects. See BRISTLETAILS.

TIAHUANACO, tē-ä-wä-nä'kō, Bolivia, the ruins of a prehistoric city, near the south shore of Lake Titicaca, in lat. 16° 42′ S., long. 68° 42′ W., about 40 miles west of La Paz city. The ruins stand on an eminence 12,930 feet above sea-level, which, from the water marks around it, seems to have been formerly an island in Lake Titicaca. The level of the lake, however, is now 135 feet lower, and its shores two miles distant. This fact, in conjunction with others, warrants the belief that these remains antedate any others known in America; they indicate a different and higher order of art than was found to exist at the time of the Spanish conquest, in any other part of that Continent. The ancient Peruvians had but the vaguest traditions concerning them, believing that the structures of which they are the remains were raised in remote ages, by giants, in a single night. The chroniclers of the Spanish conquest have described them, and their accounts do not differ materially from those of modern travelers. They are in a state of extreme dilapidation. Some of the structures seem to have been built on a pyramidal plan, and to have covered several acres; but the most remarkable features still remaining are monolithic doorways, pillars and statutes of stone, elaborately sculptored in a style wholly different from any other remains of art yet found in America. One of these doorways is 10 feet high, 13 feet broad, with an opening six feet four inches by three feet two inches, the whole cut from a single stone. Its east front has a cornice in the centre of which is a human figure of strange form, crowned with rays, interspersed with serpents with crested heads. On each side of this figure are three rows of square compartments, filled with human and other figures, of apparently symbolic design. The statues are broken, so that it is difficult to state their original dimensions; but these may be inferred from the size of the head of one, which is four feet in length and of proportionate width. The whole neighborhood is strewn with vast blocks of stone elaborately wrought, some of which measure three feet in length by 18 feet in width, and six feet in thickness. Some of these stones have been found to weigh as much as 400 tons and were transported many miles. No mortar was used in the masonry; stones grooved and tongued were held together with clamps and bronze pins. Dressing and carving of stones was done with stone and bronze tools. On some of the islands of Lake Titicaca are other monuments, of great extent, but of true Peruvian type, apparently the remains of temples destroyed on the arrival of the Spaniards. Those of the island of Coati, however, have many features in common with the ruins of Tiahuanaco, and probably belong to the same epoch, and are to be ascribed to the same unknown and mysterious people who preceded the Peruvians, as the Tulhuatecas or Toltecs did the Aztecs. Not far distant from the ancient site stands the present town of the same name, largely built from stones taken from the old ruins. Consult Stübel and Uhle, 'Die Ruinenstätte von Tiahuanaco' (Breslau 1892).

TIARA, the crown of the Pope, a cylindrical diadem with three crowns and a pointed top surmounted by a mound and a cross of gold, which the Pope wears as a symbol of sovereignty. It is placed upon the Pope's head at his coronation by the second cardinal deacon, with the words, «Receive the tiara adorned with three crowns, and know that thou art Father of princes and kings, Ruler of the world and Vicar of our Saviour, Jesus Christ.» The tiara is not worn upon purely spiritual occasions, the Pope then wearing the mitre of a bishop. The first crown is said to have been added to the mitre by Nicholas I (858–867) as a symbol of uniting the princely crown with it; the second crown was added by Boniface VIII (1294–1303); and the third, first appears on the monument of Benedict XII (1334–42).

TIBALDI, tē-bäl'dē, **Pellegrino,** Italian painter and architect: b. Bologna, 1527; d. Milan, 1598. In 1547 he commenced his profound study of Michelangelo at Rome and painted for Cardinal Poggi, in his palace at Bologna, the 'History of Ulysses.' When Caracci saw these pictures, in which the style of Michelangelo appeared in a softened and refined form he pronounced Tibaldi *il Michelangelo Riformato* — an improved version of Michelangelo. He also decorated the chapel of Saint James for the Augustinians. Among his architectural works are the palace of Cardinal Borromeo at Pavia (1562); the Church of Saint Fidelis at Milan, and the new façade of the cathedral in that city. He likewise furnished Philip II who had summond him to Spain in 1586, with the plan for the Escorial, and painted the ceiling of the library in that palace. Consult Gurlitt, 'Der Barockstil in Italien' (Stuttgart 1887); Zanotti, 'Le pitture di Pellegrino Tibaldi' (Venice 1756).

TIBER, tī'bẽr (Italian, *Tevere*), Italy, a river rising in the Apennines of Tuscany, in central Italy, about 11 miles north of Pieve San Stefano, some 4,000 feet above sea-level. It is one of the largest and most celebrated rivers of the country, has a winding course, flows 244 miles and empties into the Mediterranean, passing many noted cities on its way to the sea, which enters by two branches — the Fiumicino and Fiumara. It is navigable for small craft as far as the mouth of the Nera, a distance of about 90 miles, but for small steamers only as far as Rome where it attains a breadth of about 250 feet. Its principal tributaries are the Nera and Paglia, which also receive their own affluents. The upper course is precipitous and the mountain streams which supply its water are the cause of its frequent overflow and consequent inundations. The chief cities on its route are Perugia, Orvieto, Ostia and Rome. The swift current carries along a vast amount of sediment from which condition arose the name «yellow Tiber,» *flavus*

Tiberis, alluded to by Virgil. Consult Smith, S. A., 'The Tiber and its Tributaries' (London 1877).

TIBERIAS, tĭ-bē'rĭ-as, **Sea of.** See GALILEE, SEA OF.

TIBERIUS, tī-bē'rĭ-ŭs **(TIBERIUS CLAUDIUS NERO CÆSAR),** Roman emperor, son of Tiberius Claudius Nero, and Livia Drusilla, who was afterward married to the Emperor Augustus: b. 16 Nov. 42 B.C.; d. Misenum, 31 March 37 A.D. Brought up in the imperial household, Tiberius had by his conquests in Germany and Gaul gained the confidence of Augustus, by whom he was made a Roman consul. In 11 A.D. he was compelled, in order to retain the favor of Augustus, to divorce his wife, Vipsania Agrippina, and to marry Julia, the emperor's daughter, and in 14 A.D., shortly before the death of the emperor, he was formally adopted as his heir. According to Tacitus, the reign of Tiberius, although marked by cruelty and infamy which could have been possible to only the most profligate and dissolute of men, was rendered less tyrannous than might have been expected, by the strict maintenance of justice in matters of taxation and at times by a certain respect for the privileges of the Senate, and the rights of the common people, a course to be commended in a period of absolute despotism. The atrocious disregard of human life and liberty wherever his own private interests were at stake could, however, scarcely have been equaled. It was in this reign that the crime of «læsa majestas» was established. Consult Jerome, T. S., 'The Tacitean Tiberius' (in 'Classical Philology,' Vol. VII, Chicago 1912); Mommsen, 'The Roman Provinces from Augustus to Diocletian' (1886); Schiller, H., 'Geschichte der römischen Kaizerzeit' (Gotha 1883); Tarver, J. C., 'Tiberius the Tyrant' (New York 1902).

TIBERIUS CONSTANTINE (TIBERIUS II), emperor of Byzantium: b. Thrace; d. Byzantium, 582 A.D. He was brought up by the Emperor Justin II whom he succeeded on the throne of the Eastern Empire in 578. It was during his reign that the great influx of Huns and Slavs in the north and east, and that of the Lombards in the west, began seriously to threaten the Roman empire.

TIBET, tĭb'ĕt or tĭ-bĕt, or **THIBET,** a country of central Asia, under Chinese suzerainty, lying between latitude 28° and 36° N., and between long. 79° and 103° E. It is bounded on the north by East (Chinese) Turkestan, on the east by China proper, on the south by British India, Bhutan and Nepal and on the west by the Indian state of Kashmir. The area is estimated at about 463,200 square miles. Tibet forms the most extensive and loftiest plateau region in the world. It is structurally a complex of faulted mountains whose intervening valleys have been filled up with detritus, converting them into plains whose general level lies from 10,000 to 17,000 feet above the sea, while the mountains tower almost as high again above them. The main Himalaya range runs along the southwestern boundary and the Karakoram with its outrunners traverses the western part of the country. These ranges have numerous peaks between 20,000 and 29,000 feet in height. On the northern boundary runs the Kuen-Lun Range, sending numerous spurs and offshots into the plateau. The eastern half of Tibet is traversed by a system of more or less parallel ranges with a southeast trend. The enclosed plains in western and northern Tibet form closed drainage basins, very poorly watered, and containing salt lakes. The eastern longitudinal valleys are drained by the headwaters of the Yang-tse-kiang, Hoang-ho and Salwin rivers and in the south, along the northern base of the Himalayas, run the Indus to the west and the Brahmaputra to the east. The climate is excessively dry, with great and sudden fluctuations in temperature, and severe cold and biting north winds in winter. The vegetation is scanty and characteristic of desert and alpine regions. There are green meadows only along the streams and in the eastern mountains are forests of birch, poplar and coniferous trees. Wild animals are very numerous along the watered regions and antelopes, yak oxen and wild asses are characteristic of the steppes.

The inhabitants, who number about 2,000,000, are of a semi-civilized Mongolian race somewhat akin to the Burmese. In the north they are nomadic, but in the south they are settled in substantial houses of stone or sun-dried brick, and cultivate the soil along the river valleys. The industries are not important, but there is a considerable trade with China, and wool, furs, musk, gold, borax and salt are exported. The language of the people is similar to the Chinese, but has taken on polysyllabic characters. A considerable amount of literature, mainly religious, has been accumulated, and printing has been practised for centuries. The prevailing religion is Buddhism, of the form known as Lamaism. The priesthood is exceedingly numerous and the government is a theocracy. At its head is the Grand Lama or Dalai Lama, who resides at Lhasa (q.v.), the capital, and who claims to be the head of the Buddhist world. This priest government has enforced a strict exclusion of non-Buddhist foreigners, particularly from the capital. A Chinese resident was permanently stationed at Lhasa. Russian diplomatic influence seemed to have gained a foothold in Tibet when, in 1903, the British Indian government took the occasion of the non-compliance of the Tibetans with the terms of the treaties of 1890 and 1893, governing frontier trade relations, to send a military expedition across the boundary. The avowed purpose was to negotiate with the Tibetan government, but the latter declined to negotiate and the British column pushed on toward Lhasa. On 31 March 1904 at Guru where the Tibetans had built a wall across the highway to oppose the advance, 1,500 of their soldiers were flanked and effectively enclosed in a circle. An attempt to disperse them, and make them retire without firing on them, was met by the Tibetan general wounding a Sikh by a pistol shot which was the signal for a general onslaught by the Tibetans. A terrible magazine rifle fire, and the bringing into action of a mountain battery resulted in the slaughter of about 400 of their soldiers, the British subsequently occupying their camp. The advance also met with serious opposition at the Karo-la, and at Gyantse jong or castle, where for a time they were besieged by thousands of Tibetans. The expedition eventually reached Lhasa; after long negotiations, ended only by the threat of enforcing compliance, Colonel Younghusband concluded a treaty which was afterward censured by the Indian government as in excess of his instruction. Protest from the Chinese government led to the Anglo-Chinese convention in 1906, whereby British evacuation of Chumbi Valley was secured and China, as Suzerain power of Tibet, paid an indemnity of 2,500,000 rupees. The agreement entered into between the two countries at this time was further strengthened by the conclusion of trade regulations between India and Tibet (1908). At the time of the Chinese Revolution in 1911 the Tibetans expelled the Chinese garrison, and an expedition subsequently sent out from Szechuan and Yunnan was withdrawn because of Great Britain's disapproval. In 1912 the British government outlined its attitude toward the Tibetan question, in accordance with the provisions of the treaty of 1906, objecting to Chinese assertion of sovereignty over Tibet. A tripartite conference was opened at Simla in 1913, but was dissolved without reaching any satisfactory agreement. Since that time Great Britain has declined to reopen negotiations. Consult Coales, O., 'Eastern Tibet' (in *Geographical Journal*, April 1919); Gerard, F., 'Tibet: The Country and its Inhabitants' (tr. from French, London 1904); Landon, P., 'Lhasa: The Tibet Expedition, 1903–04' (2d ed., London 1906); Lansdell, H., 'Chinese Central Asia' (2 vols., London 1893); Rijnhart, S. C., 'With the Tibetans in Tent and Temple' (London 1901); Younghusband, F. E., 'India and Tibet' (London 1910).

TIBET DOG, or **TIBET MASTIFF,** a breed of dogs about the size of a Newfoundland dog, but with a head resembling that of the mastiff, and having the flews large and pendent. The color is usually deep black, with a bright brown spot over each eye; the hair is long and the tail bushy and well curled. This variety is extremely savage, and has been known from classic times, when it was employed by the Romans, especially under the emperors, in the games of the circus.

TIBIA. See ANATOMY; OSTEOLOGY, HUMAN.

TIBULLUS, Albius, Roman poet: b. about 54; d. about 19 B.C. He belonged to the equestrian order, and was on intimate terms with Messala (q.v.), whom in 31 he accompanied in a campaign in Aquitanian Gaul. He set out with him thence to the East also, but was forced through ill-health to land and be left behind at Corcyra. Henceforth he lived on his estate, between Tibur and Præneste. Horace was warmly attached to him and addresses to him one of his epistles, in which he credits his friend with the possession of a tender heart, beauty, wealth, good health and good taste in enjoying life. There are four books of elegies under his name, but the third and a part of the fourth are spurious. These poems are among the most perfect of their kind which have come down to us from classical antiquity. The elegies of Tibullus are characterized by agreeable simplicity and tender feeling, and are free from the insipid prolixity into which Ovid frequently falls. The chief editions are those of Bährens (Leipzig 1878); and Hiller (ib. 1885); Lachmann (1829); Müller (ib. 1885); Postgate (1906). There is a translation by Cranstoun (1872). Consult Duff, J. W., 'A Literary History of Rome' (New York 1909); Sellar, W. Y., 'Horace and the Elegiac Poets' (Oxford 1892); Teuffel, W. S., 'Geschichte der römischen Literatur' (Vol. II, 3d ed., Munich 1911).

TIBURON, tē-boo-rōn, Mexico, an island in the Gulf of California, situated in the upper part of the gulf, 230 miles from the mouth of the Colorado River, and separated from the coast of Sonora by a channel from two to five miles wide. It is 30 miles long and from 10 to 20 miles wide, and covered with grass and desert vegetation. It is inhabited by the Ceris or Seris Indians, who have been left almost wholly to themselves by the Mexican government, and still live in a primitive state of nature. They are warlike and feared by the neighboring tribes on the mainland; use poisoned arrows, and are said to practise cannibalism.

TIC-DOULOUREUX, tĭk'doo-loo-rē'. See FACIAL NEURALGIA; NEURALGIA.

TICAO, tē-kow', Philippines, one of the islands of Masbate province, lying northeast of Masbate Island, and southwest of Sorsogón, Luzon, area 140 square miles; with dependent islands 149 square miles. It is long and narrow, extending 23 miles from northwest to southeast, and narrowing gradually from a width of eight miles in the north to the southern point Cape San Rafael; the surface is rugged with many small mountain groups, and single peaks; the highest elevation in the northwest is 1,525 feet. The west coast is steep and rugged, the east coast indented by several small bays. Hemp, rice, sugarcane, cotton and chocolate are raised in small quantities; and gold is obtained from the river sands. The more important occupations of the people are stock-raising, weaving, fishing and hunting. Pop. 10,183.

TICHBORNE (tĭch'bôrn) **TRIAL,** a famous English lawsuit in which was contested the validity of the claim of one Thomas Castro that he was Roger Charles Tichborne, heir of the Tichborne estates. Roger Charles, the eldest son of Sir Alfred Joseph Tichborne, died at sea in 1854 and upon the death of the second son, in 1866, the youngest was acknowledged heir. But Lady Tichborne was not satisfied that her eldest son was really dead, and so she advertised for him. Castro, a butcher from Wagga Wagga, Australia, also known as Arthur Orton, of Wapping, came forward and claimed to be Roger, the rightful heir. He was accepted by Lady Tichborne, who, however, died before his suit to recover the estate began. The trial lasted 103 days and was ended by Castro being non-suited, 6 March 1872. He was arrested and charged with perjury and a trial of 188 days followed, a verdict of guilty being found 28 Feb. 1874. Castro was sentenced to 14 years' imprisonment with hard labor. He was discharged on a ticket-of-leave in 1884, confessed his imposture in 1895, and died in poverty and oblivion in 1898. The second trial, which was the longest in the history of the English courts, cost £55,315. Consult 'The Tichborne Romance' (Manchester 1871).

TICINO, tē-chē'nō (German *Tessin*), Switzerland, a canton situated on the southern frontier of the republic, and bounded on the east, south and west by Italy. Area, 1,088 square miles. The Saint Gotthard group of the Lepontine Alps forms the northern and the Adula Alps the eastern boundary. Ramifications of these fill up the canton, but are cut by the valley of the Ticino River. The latter drains practically the whole canton, and empties into Lake Maggiore, which extends some distance across the southern boundary. The canton thus belongs to the basin of the Po. The upper mountain regions are rocky, but the southern part of the canton is very fertile, producing grain, fruits and grapes. Large numbers of goats are raised in the mountains. The principal mining industries are granite and marble quarrying. Commerce and manufactures are unimportant, although there is a considerable tourist traffic over the Saint Gotthard Railroad, which traverses the canton. The capital is Bellinzona (q.v.). In 1803 the canton of Ticino was formed by the union of the cantons of Bellinzona and Lugano, formerly part of the Helvetian Republic, and it was received as a full member of the Swiss Confederation. Pop. 158,556. See SWITZERLAND.

TICINO (German and French, *Tessin*), river of Switzerland and northern Italy, rising on Mount Saint Gotthard, and flowing in a general southeast direction, first as a rapid torrent through the canton of Ticino, then through Lake Maggiore, and finally as a clear, navigable stream on the boundary between Piėdmont and Lombardy. After passing Pavia it joins the Po. Length, exclusive of Lake Maggiore, 108 miles.

TICKELL, Thomas, English poet: b. Bridekirk, Cumberland, 1686; d. Bath, Somerset, 23 April 1740. He was educated at Queen's College, Oxford, a fellowship of which he held 1710–26. He was the friend of Addison, who introduced him both into the world of letters and public life, and on becoming in 1717 secretary of state made Tickell under-secretary. He held the office of secretary to the Lords Justices of Ireland from about 1724 till his death. He translated the first book of the 'Iliad, about the time of the appearance of the first part of Pope's 'Homer.' Addison declared that Tickell's version was the best, while Pope professed to believe it the work of Addison himself and wrote in reply the famous satire on Atticus. But without doubt Tickell made his own translation, which Addison corrected. Tickell's longest poem is 'Kensington Gardens' (1722); his most popular, the ballad of 'Colin and Lucy'; while his finest is the elegy to Addison prefixed to his edition of Addison's works (1721). Consult Johnson, Samuel, 'Lives of the Poets' (Oxford 1905).

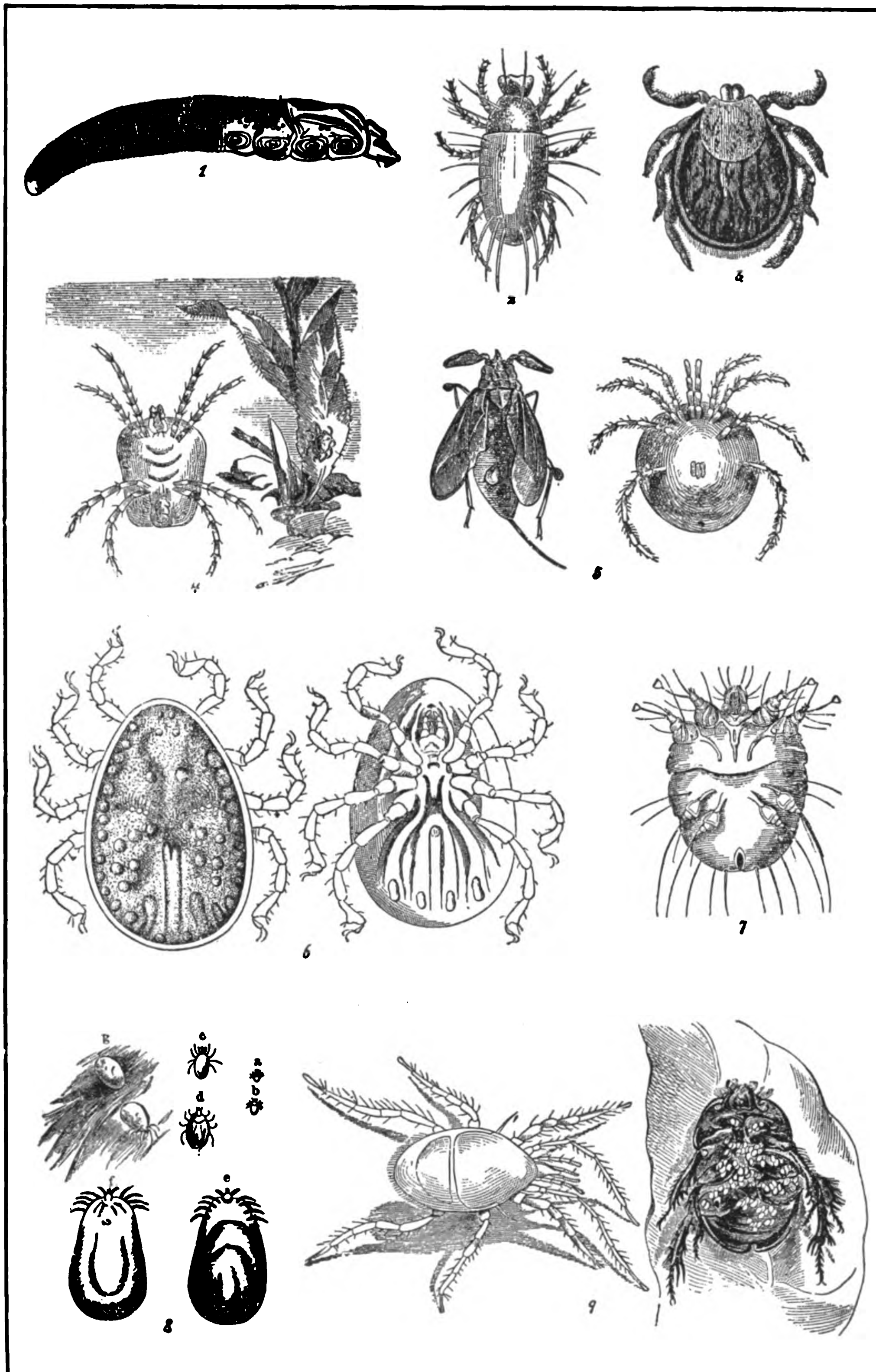
TICKET-OF-LEAVE, a written license granted by the English government, whereby a penal convict was given his liberty for good behavior before the expiration of his sentence. It originated in the permit granted to prisoners transferred to the colonies, but it came into domestic use in England after 1840, when the colonies refused to receive more convicts. Certain restrictions were imposed on the recipient, requiring that he report to the police at stated intervals until his term expired, that he should not make change of address without notifying the police, etc. The system was much abused and it was said that in 1856, 2,666 convicts were thus liberated. The number of crimes committed increased and the necessity for more stringent measures led to the adoption of the mark system, under which only those convicts, sentenced for terms of more than two years and whose marks for good behavior and industry showed that they were entitled to it, were granted the license. The effectiveness of such a system is greatly increased by the co-operation of many charitable organizations which use every possible means to re-establish the ex-convict and to enable him to lead an honest, industrious life.

TICKNOR, Francis Orrey, American physician and poet: b. Baldwin County, Ga., 1822; d. near Columbus, Ga., 1874. He studied medicine and engaged in practice near Columbus. His verse, particularly that concerning the Civil War, was highly popular throughout the South. Several of his poems are in Stedman's 'Anthology,' and after his death his verses were collected and published with a biographical sketch by P. H. Hayne, 'Virginians of the Valley, and Other Poems' (1879).

TICKNOR, George, American historian: b. Boston, 1 Aug. 1791; d. there, 26 Jan. 1871. He was graduated at Dartmouth in 1807, and was admitted to the bar in 1813, but never adopted the law as an active profession. He lived in Europe 1815–19 for the purpose of pursuing his studies, and on his return was appointed to the Smith professorship of modern languages and literature in Harvard. In 1835 he resigned his professorship, and for the next three years traveled in Europe. On his return he devoted himself to writing a 'History of Spanish Literature,' published in 1849, in three volumes, a corrected and enlarged edition appearing in 1863. Its value was at once recognized by scholars and it was translated into Spanish, French and German. He produced in 1863 a 'Memoir of Prescott,' the historian. He also wrote 'Outline of the Principal Events in the Life of General Lafayette' (1825); 'Remarks on Changes lately Proposed or Adopted in Harvard University' (1825); 'Remarks on the Life and Writings of Daniel Webster' (1831); 'Lecture on the Best Methods of Teaching the Living Languages' (1832). Consult Hillard, George S., and Ticknor, Mrs. Anna and Ticknor, Anna Eliot, 'Life, Letters and Journals of George Ticknor' (2 vols., 1876), critical ed., by Ferris Greenlet (1909).

TICKS AND MITES, small arthropods usually considered to be an order (*Acarida*) of the class *Arachnida* (q.v.). They have the regions of the body the most completely coalesced of any articulated animals, for not only are the head and thorax more or less united to form a cephalothorax, but the latter is continuous with the abdomen, often without the slightest indication of the line of union, and except in a few cases the abdomen is entirely unsegmented. The mouth-parts usually form a piercing and suctorial proboscis composed of the cheliceræ and pedipalpi, the latter being made up in part of a jointed, usually tactile palpus, while the cheliceræ may be stiliform and un-

TICKS AND MITES



1 Follicle Mite or "Blackhead" (Demodex homonis)
2 Cheese Mite (Tyroglyphus siro)
3 Tick (Ixodes reduvius)
4 Scarlet Mites (Trombidium holosericeum)
5 Water Mite (Atax spinipes)
6 Pigeon Tick (Argas reflexus)
7 Itch Mite (Sarcoptes hominis)
8 Tick (Ixodes ricinus)
9 A Beetle Mite (Gamasus coleoptratorum) at the left shown enlarged; at the right, devouring a beetle

jointed or two-jointed and clawed or chelate. Typically the mature forms or imagoes have four pairs of walking legs of from five to eight joints terminated by variously arranged claws, stalked or sessile suckers or pads; but the legs may be variously modified, reduced to mere tubercles, to two pairs or disappear altogether in some parasitic forms. Respiration is effected by means of simple or branched tracheæ opening by from one to three pairs of stigmatæ at the bases of the legs, or by means of a pair of air-sacs opening at the base of the proboscis or on the back or, in the absence of all special respiratory organs, may be purely integumentary. The alimentary canal is commonly a spacious sac which may be forked or much branched. In most cases there is no blood-vascular system. The sexes are separated, the generative ducts open on the base of the abdomen, and fertilization is accomplished through copulation. A few are parthenogenetic and sexual dimorphism is frequent. They are oviparous, ovo-viviparous or viviparous. The larvæ frequently differ greatly from the imagoes in appearance and habits and almost always have three pairs of legs. After a few molts, usually two, they form nymphs or pupæ which also may be very different, and after a single molt metamorphose into the mature form or imago.

Mites and ticks are found in all parts of the world and under every variety of environment. Many are parasitic either temporarily or permanently, and on both animals and plants, a few are commensals in ants' nests, etc., others are predaceous, and seize and suck the juices from weaker animals, some live in decaying vegetable substances, many in damp earth, in moss or under the bark of trees, many are aquatic either in fresh water or the sea, and some of the marine forms descend to great depths. While most of the members of this order have no direct relation to human affairs, many affect our interests in important and manifold ways. Some, like the itch-mites, are the cause of annoying diseases of man and animals, some like the cattle ticks are the bearers of disease-producing parasites, some are seriously destructive to our crops or to manufactured food-products, etc.; and many are beneficial as destroyers of harmful insects and their eggs. Owing to their great powers of reproduction and their tenacity of life, the harmful species are difficult to combat, preparations of sulphur and lime or powerful insecticides applied directly to the colonies being the most effective remedies. The number of known species already amounts to thousands, although the smaller mites have been little studied outside of Europe. They vary in size from the microscopic mites to the large cattle ticks about an inch in length. Differing greatly not only in habits and appearance but also in structure, the *Acarida* are divided by systematists into numerous families and subfamilies, of which a few representatives may be mentioned.

The *Oribatidæ* is an extensive family of 20 genera and 200 to 300 species of free-living forms with hard skins and robust bodies and usually three pairs of stalked stigmatæ and simple tracheæ. They are mostly vegetable feeders, never parasitic and with the exception of a few aquatic forms lives in damp earth under leaves, bark, etc.

The *Gamasidæ* are somewhat similar, with rounded bodies and a hard skin, but have only a single pair of stigmatæ at the base of the second pair of legs. The blood system is well developed. They often swarm on the under side of rove-beetles, carrion-beetles and other insects and some are parasitic on bats and birds; 35 genera and perhaps 200 species are already known.

The *Ixodidæ* are the ticks, large blood-sucking species, with ovoid bodies and leathery skin capable of great extension. They are temporary parasites of vertebrates, chiefly of birds and mammals. As a rule the eggs are deposited in the ground; the newly hatched larvæ have three pairs of long clawed legs with which they attach themselves to a host, insert the beak and suck the fluids. When ready to slough they may drop off, seek concealment until the skin is changed, when the same maneuver is repeated. After passing the larval and nymphal states the imagoes live among herbage and shrubbery and upon opportunity again attach themselves, but usually in pairs, to some warm-blooded host, inserting the strong beak and drawing blood while copulation takes place. The fertilized female becomes greatly distended, often to a spherical form, drops off and deposits her eggs, often to the number of 20,000 to 30,000. The large cattle-tick (*Boophilus bovis*) of the western ranges, now known to be the intermediate host of the parasite of Texas fever and a great scourge to cattle and other animals, is an example. Others are the wood-tick (*Ixodes unipunctata*), so common in New England, and certain European species, one a parasite of poultry and introduced into the United States, as the related dove-tick also has been.

The *Hydrachnidæ* are the attractive and familiar water-mites, another large group of 40 genera and about 500 species. The adults, remarkable for their sexual dimorphism and brilliant colors, suck the juices of small crustaceans while the young are parasitic on aquatic insects and mussels. The brilliant scarlet eggs of some species are frequently found attached to aquatic plants and stones in a mass of jelly. A related family containing mostly marine predaceous forms is the *Halacaridæ*. An allied family is the *Trombidiidæ*, including the scarlet mites and the red spiders so well known to horticulturists. A very common one is *Tetrarhynchus telearius*, which spins a web on the under side of leaves and is very destructive to plants during hot dry weather. Others cause great damage to orange and lemon groves. The young are parasitic on insects.

The disgusting itch-mites form a family (*Sarcoptidæ*) of short, rounded forms which lack eyes, tracheæ and stigmatæ altogether. They are microscopic and burrow in the skin of various animals, causing the diseases known as itch and mange, which are very difficult to eradicate but usually yield to persistent applications of sulphur washes. No less than 68 genera and 550 species parasitic on mammals, birds and insects have been described. (See Itch). Sheep-scab and mange in various domestic animals are caused by related mites of the genera *Psoroptes* and *Symbiotes*. They all have the feet wonderfully provided with adhesive organs in the form of hooks, bristles and sucking cups. Closely allied are the *Tyroglyphidæ*, comprising perhaps 50 species of minute forms with biting jaws. They are chiefly remarkable for their great reproductive capacity and the enormous numbers in which they occur in slowly decomposing vegetable substances, etc. Here belong the cheese-mites (*Tyroglyphus siro* and *T. longior*) which are cultivated and sown in certain cheeses in order to give them an appearance of maturity and an acid flavor. Many similar species infest stored grain, dried fruits, etc., and some, like *Aleurobius* and *Rhizoglyphus*, destroy living roots, bulbs and grains. Another one abounds in unrefined sugars.

Two strictly parasitic families in which the body has become elongated and worm-like and otherwise degenerate are *Demodicidæ* and *Eriophydidæ*. The former live in the hair follicles and skin glands of man and domesticated animals. *Demodex folliculorum* sometimes causes the «blackheads» which appear about the human nose; similar species infest the pig, dog, sheep, ox and other animals. That of the ox sometimes so perforates the skin that it has little value for leather. In these forms the legs are very small and degenerated and one pair may be lost. The second family is that of the gall-mites which have but two pairs of legs, the posterior being sometimes represented by bristles. They form galls in the buds and leaves of plants whose juices they suck. Most of the species are confined to a particular species of plant, so that the 235 which have been described are probably but a small representation of those actually in existence. Some are parasitic in the galls made by others, recalling the inquilines among the gall flies.

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J. Percy Moore,
University of Pennsylvania.

TICONDEROGA, tī-kŏn-dē-rō'gạ, N. Y., village, Essex County, on the stream which is the outlet of Lake George, and on the Delaware and Hudson and the Rutland railroads, about 95 miles north by east of Albany, and a short distance from lakes Champlain and George. In the vicinity are rich deposits of crystalline graphite, the chief source of the supply in the United States. The village is in an agricultural region. The good water power is utilized to some extent for manufacturing. The chief manufactures are lumber products, wood pulp, paper and dairy products.

The history of Ticonderoga and vicinity begins with the early settlement of Vermont and northern New York. In 1755 a fort was built here, by the French. They called it Fort Carillon, on account of the caroling or chiming of the waters. The value of the site, near the head of Lake Champlain and at the entrance to Lake George which, with a short portage, formed a waterway to the Hudson, was recognized by both the French and English. Two years after the erection of Fort Carillon it was garrisoned by a force of 9,000 men under Montcalm. Wishing to extend the power secured by so advantageous a position, Montcalm attacked and captured Fort William Henry on Lake George. In July the following year General Abercrombie attempted to capture Fort Carillon, and although he had a force of 15,000, he was unsuccessful; his loss was about 2,000. In 1759 another and successful effort was made to wrest the fort from the French; General Amherst with a force of 12,000 captured both Carillon and Crown Point. After the beginning of the Revolutionary War, the whole region bordering on Lake Champlain, Lake George and the Hudson River became a battle ground. On 10 May 1775, a small force of Americans, less than 100 in number and known as «Green Mountain Boys,» under Ethan Allen (q.v.), demanded the British commander to surrender «in the name of the Great Jehovah and the Continental Congress!» and thus, despite the fact that Allen held no commission and also that the Continental Congress had not yet convened, captured the fort, then called Ticonderoga. Burgoyne's plan of campaign included regaining this fort, and on 30 June 1777 he endeavored to capture the Americans, but failed. On 5 July of the same year, he made another attempt and this time succeeded. Later other engagements took place here and in the vicinity, but the English kept possession until after the surrender of Burgoyne. In 1780 an English force occupied the fort for a short time. At the close of the wars with England the fort ceased to be of importance, and as it was not occupied it soon became a ruin. Near the village stands a part of the gray stone walls of the old fort. Many tourists visit the village each year, and it has some note as a summer resort. Pop. 2,918.

TICONDEROGA, Expedition Against, an incident in the American Revolutionary War. See Allen, Ethan; Ticonderoga.

TICPOLONGA, the name in Ceylon of Russell's viper (*Daboia russellii*) common in the south of India, Ceylon and Burma. See Russell's Viper.

TICS, spasmodic contractions of muscles, especially those which occur in the muscles of the face. Such affections are characterized by painful muscular twitching. The term tic, as referring to facial spasm, is especially applied to tic-douloureux. See Facial Neuralgia.

TICUNA, te-koo'nä, or **TUCUNA,** too-koo'nä, a tribe of aboriginal Indians found in the forests of Brazil and Peru, around the confluence of the Javary and Marañon or Upper Amazon. They are of slender but good physique, have dark skins, and live in a state of nature, their sole adornments being feather armlets and monkey teeth necklets. They live by fishing and hunting, and are distinguished for their honesty and straightforward dealings. Their birth, death and other ceremonials and customs are interesting. Early in the 18th century the Jesuits established missions among these people. Consult Chamberlain, A. F., in 'Journal de la Société des Américanistes de Paris' (Vol. VII, Paris 1910).

TIDE-MILL, a water-mill so constructed as to utilize the action of the tide. This is usually accomplished by one of two methods. The first consists of shutting off the water in a reservoir at flood tide, its escape through a race-way giving the motion to the mill. In such tide-mills the return of the tide through the sluice may also be utilized. The other and less expensive method involves the placing of a horizontal wheel in the water to be turned by the current either in ebb or flow. The motion of this mill is not uniform; it attains its greatest velocity at half tide and is suspended entirely at the turn of the tide; but with exception of this suspension a uniform velocity can be obtained through the use of regulative machinery. The old London tide-mills, in use in the river Thames, were built on a platform which was entirely afloat, water-wheel, mill-room and all. Tide-mills have never attained any great success owing to the inconvenience of so irregular a motive power. But in recently projected mills an attempt is made to obviate this difficulty by the use of an ingeniously constructed tidal-motor.

TIDEMAND, Adolph, Norwegian painter: b. Mandal, 1814; d. Christiania, 1876. He studied at Copenhagen and at Düsseldorf under Schadow, afterward going to Munich and Rome. Among his works are the large historical compositions 'Gustavus Vasa Addressing the Dalecarlians' and 'Devotional Meeting of the Haugainer,' and many genre subjects, such as the cycle of 10 pictures illustrating 'Norwegian Peasant Life'; 'Grandmother's Bridal Crown,' and 'The Wolf Hunter's Tale.' He was for many years painter to the king.

TIDES. 1. Introductory.— Persons living along the seashore are familiar with a semi-daily rising and falling of the waters, which, although generally amounting to only a few feet, often suffices to cover and bare by turns wide stretches of the sea-shore. Without tide tables, or any knowledge of the moon's position, the approximate time of the tide can be foretold from its observed time of occurrence on a previous day, by allowing 50 minutes for its daily retardation. Toward and after the time of Cæsar, the Romans were well acquainted with ocean tides as the writings of Cæsar, Seneca, Pliny the Elder, Claudianus, and others clearly show. By referring the tides to the attraction of the moon and sun, Newton took the first important step in their explanation. Since his time important investigations of the laws of the tides have been made by Laplace, Airy, Kelvin, G. H. Darwin, H. Poincaré and many others.

2. Definitions, etc.— The tide is the periodic rising and falling of oceanic and other large bodies of water, due mainly to the attraction of the moon and sun as the earth rotates upon its axis. Remarkable stages of the water level at a given place, whether due to earthquakes, gales or other causes which probably have no definite law of recurrence, although popularly known as "tidal waves," cannot be regarded as belonging to tidal phenomena. The rising and falling is accompanied by, and depends upon, lateral or horizontal movements of the waters called tidal currents or tidal streams or the flow and ebb. Their periodic character distinguishes them from ordinary ocean currents. The tide rises until it reaches a maximum height called high water and then falls until it reaches a minimum height called low water. The difference in height between a high and a low water is called a range of tide. At most ports two high waters and two low waters occur each lunar day. The average length of a lunar day is 24 hours 50 minutes 28 seconds. The interval of time between the transit of the moon across the meridian and the occurrence of high or low water is called a lunitidal interval. The average value of the high-water lunitidal interval at any seaport is sometimes called the corrected establishment to distinguish it from the high-water lunitidal interval on the days of new and full moon, which is known as the establishment, or the vulgar establishment, of the port.

At the times of new and full moon the tidal forces of the moon and sun act in the same direction, whereas at first and last quarters they oppose each other. When they unite their forces we have spring tides, characterized by large ranges of the tide; when they are opposed, neap tides, having small ranges. The spring and neap tides usually occur soon after the corresponding phases of the moon. The interval is called the retard or age of the tide, or age of the phase inequality, and is usually less than 60 hours. The lunitidal intervals have their mean values at the times of spring and neap tides; the tides occur a fraction of an hour earlier between spring and neap tides, and later between neap and springs. Other things being equal, the range of tide is greater than usual by about one-sixth part when the moon is near perigee and about as much less than usual when near apogee. An increase or decrease of about one-tenth part of the range occurs when the moon is near the equator or near its point of extreme declination, respectively.

Diurnal inequalities among the four tides of a day are due to the presence of a diurnal wave or partial tide, whose period is approximately 24 hours. The cause of this wave lies in the fact that if the moon is north or south of the equator, its tidal forces are somewhat different both in magnitude and in direction when two times half a lunar day apart are compared.

3. The Tidal Forces.— All particles of the earth (the seas included) will continue to occupy positions fixed relatively to one another if no other forces are impressed upon them than the following: The earth's attraction; its centrifugal force of axial rotation; and a force acting upon all of its particles alike, for example, the centrifugal force due to the revolution of the earth about the centre of gravity of earth and moon. If an extraneous force does not act upon all particles alike, then motions will be set up in the yielding parts. The attraction of the moon upon a given particle (near the surface, say) is along a line drawn (at any given instant) from the particle to the moon's centre; its intensity, which is inversely proportional to the square of the distance, and its local direction (that is, direction with respect to the earth's surface) continually change as the earth rotates upon its axis. The attraction of the moon upon a particle at the earth's centre (or upon the earth as a whole) is along a line drawn from the earth's centre to that of the moon; it is independent of the earth's axial rotation. Because the action of the moon upon the surface particle differs from its action upon the particle at the earth's centre there results a tendency to produce motion relatively to the earth's centre. A consideration of this tendency will enable us to answer the question why there should be two high waters each lunar day, instead of only one high water. In a single sentence, the reason is that the moon attracts the waters on the hemisphere facing the moon more powerfully than it does the earth; but attracts the earth in general more powerfully than it does the waters on the farther side of the earth. The difference between the action of the moon at any point of the ocean and its action on the centre of the earth is the tide-producing force at the specified point. It is not difficult to show that, to higher powers of the small quantity a/r, the vertical and horizontal components of the moon's tide-producing force are very nearly $\frac{M}{E}\frac{a^3}{r^3}g\,(3\cos^2\theta - 1)$ and $\frac{3}{2}\frac{M}{E}\frac{a^3}{r^3}\,g\sin 2\theta$ respectively, where M denotes the mass of the moon, E that of the earth, g the force of gravity, a the mean radius of the earth, r the distance between centres of earth and moon, and θ the zenith distance of the moon corrected for parallax. The numerical value of $\frac{M}{E}\;\frac{a^3}{r^3}$, when r has its mean value, is 0.000000056; and so the vertical force has a range of 0.000000168g, as has also the horizontal force. The solar tidal force is 46 per cent that of the lunar. The tides are mainly due to the horizontal component of the forces. These are the forces which deflect a plumb line, although by an amount so small that it can hardly be measured. The deviation, in case of the moon, amounts to only 0."017 either way from the mean vertical. For a sufficiently deep body of water extending 163 nautical miles along the equator the range of tide at either end will be one inch.

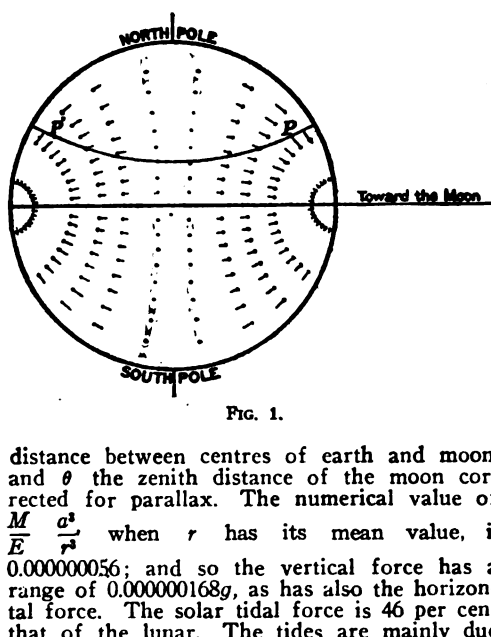

Fig. 1.

The system of arrows in Figs. 1, 2, 3 are intended to represent the horizontal component of the moon's tide-producing force at various places on the earth's surface. The arrows located upon the same small circle are supposed to be of equal length, and all arrows are supposed to lie in a system of great circles which meet in a point directly under the moon and, of course, in the antipodal point. At these two points and along a great circle midway between them the length of the arrows is zero; in other words, the force vanishes. The system of arrows is fixed with respect to the moon, and so sweeps over the surface of the earth as the moon performs her apparent daily revolution. The system shifts somewhat when the moon is north or south of the equator. At any point P on the earth's surface, the moon being upon the equator, the horizontal forces are equal in magnitude and direction to the horizontal forces at P', a point upon the same parallel of latitude as P, but 180° distant in longitude; or, what amounts to the same thing, they repeat themselves at any given point P every half lunar day, or 12h. 25m. 14s. on an average. But when the moon is not upon the equator, the forces are generally not the same at P and P', either in magnitude or in direction, and so do not exactly repeat themselves every half lunar day. This alternation of the forces gives rise to a diurnal inequality in the tides. It will be noticed that for places situated upon either side of the equator, the forces have, when the moon is upon the equator, a meridional component directed from the poles toward the equator, and

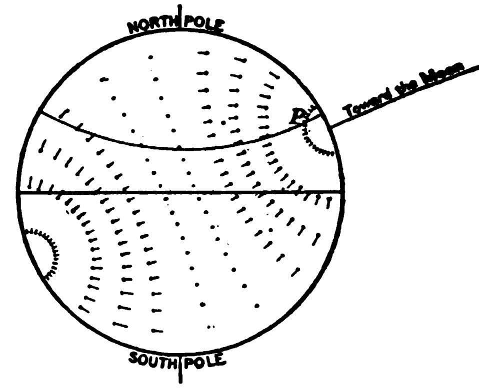

Fig. 2.

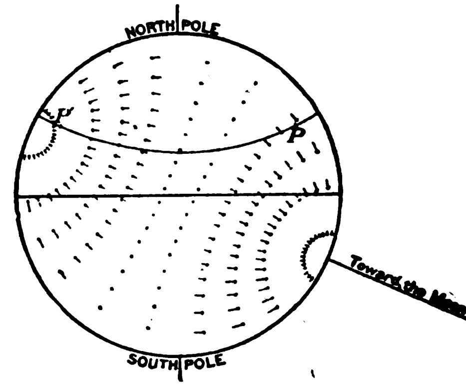

Fig. 3.

that this component nowhere points from the equator toward the poles; consequently the existence of the moon causes the water (half-tide level) at the equator to be higher than it would otherwise have been. The moon's movement in declination, therefore, causes a fortnightly fluctuation in half-tide level. Similarly the sun produces a semi-annual fluctuation.

4. Real Equilibrium Tides.— If in the case of any body of water, its free period be several times smaller than the period of the tidal forces, say less than three or four hours, the surface will at every instant be normal to the plumb line as disturbed by these forces. In particular, consider the mean lunar semi-diurnal tide of a deep lake situated in north latitude. Upon referring to Fig. 4 it may be inferred that high water will occur at a point south of the no-tide point when the moon is on meridian; at a point west of the no-tide point at 3 o'clock, lunar time; at a point north of it, at 6 o'clock; at a point east of it, at 9 o'clock. The no-tide point is the centre of gravity of the surface. This theory nearly explains the tides found in Lake Superior and the semi-diurnal tide in the eastern portion of the Mediterranean Sea; it partially explains the semi-diurnal tides in the Gulf of Mexico and the Caribbean Sea, and the diurnal tides in the Atlantic Ocean east of the United States.

5. Hypothetical Equilibrium Tides.— If a spherical body like the earth were entirely covered by an ocean so deep that its free period of oscillation would be several times smaller than the period of the tidal forces, the tidal forces of the moon would cause the surface of the ocean to assume the form of an ellipsoid of revolution with the longer axis pointing toward the moon's centre. For any zenith distance θ of the moon the height of the tide above the undisturbed spherical surface becomes $\frac{1}{2}\frac{M}{E}\frac{a^3}{r^3}\frac{a}{1-\frac{3}{5}\sigma/\delta e}(3\cos^2\theta-1)$ where σ denotes the density of the water and δe that of the earth. The numerical value of $\frac{M}{E}\frac{a^4}{r^3}$ is 1.17 feet. The corresponding value for the sun is 0.54 foot. If the $\sigma/\delta e = 0$, the range of the hypothetical lunar tide becomes 1.8 feet; if $\sigma/\delta e = 1$, the range becomes 4.4 feet. In case of the earth $\sigma/\delta e = \frac{2}{11}$.

The hypothetical tide just described can be easily calculated for any time and place and is known as the uncorrected equilibrium tide. It bears no resemblance to the actual tide of our oceans.

6. Some Dynamical Questions Involved in the Subject.— Because the requirements for equilibrium tides are seldom found in the oceans, their waters must be treated as aggregates of heavy particles performing some kind of oscillatory motion. A progressive free wave in a canal has as its velocity of propagation $\sqrt{gh}$ and for the maximum velocity of the water particles $A\sqrt{\frac{g}{h}}$ where h denotes the undisturbed depth of the water and A the amplitude of the vertical movement. The longest or fundamental period of free oscillation of a rectangular area or sheet of water is

$$\text{period} = \frac{\text{twice length of sheet}}{\sqrt{gh}}.$$

Sheets tapered or sharpened at the ends oscillate more rapidly than do rectangular ones of the same length, while sheets narrowed at the middle or broadened at the ends oscillate less rapidly. The free oscillations of a given body of water can often be approximately determined by comparing with a more simple body whose motion is known. The given body need not have a strictly uniform depth nor be completely surrounded by land.

The general equations of motion for matter upon a rotating sphere show that a moving particle of unit mass is deflected or accelerated relatively to the earth's surface, toward the right in north latitude, toward the left in south latitude, as if by a force whose numerical value is velocity $\times 0.0001458$ sin (latitude), the velocity being expressed in feet per second and the force in poundals (Ferrel's law). This divided by g or 32.1722 gives the transverse slope which a river, or strait through which there is a current, will assume on account of the deflecting force of the earth's rotation.

7. Hypothetical Dynamical Tides.— The case of an equatorial canal encircling the earth is simple and instructive, although bearing no resemblance to any existing tidal body. If the depth of the water be greater than 67,000 feet, high water will occur when the moon is on meridian (above or below the horizon); if less than 67,000 feet, low water will occur when the moon is on meridian. For the depth 67,000 feet the range of tide will become very large. If this depth be greatly increased, the range will approach its equilibrium value, which is 1.8 feet for the lunar tide; if this depth be greatly diminished, the range will approach the value 0.000,026 h, h denoting the depth. In the latter case the amplitude of the horizontal displacement will be 137 feet. For the depth of 10,000 feet the range of tide is 0.31 foot and the amplitude of the horizontal displacement 161 feet; for the depth of 20,000 feet the corresponding quantities are 0.74 foot and 196 feet, respectively. If friction proportional to the velocity be introduced, the effect will be to displace the crests of the lunar and solar wave with reference to the moon and sun, but by unequal amounts. To this has been attributed the age of the tide.

8. Partial Explanation of Ocean Tides.— From §§ 3, 4 an idea of the magnitude of the equilibrium tide can be obtained. It represents the direct effect of the action of the moon upon the waters where the body is so small and deep that its motion can be ignored. In a larger body whose free period is quite different from that of the tidal forces it is reasonable to suppose that tides even smaller than the equilibrium tides will be raised. In § 7 this was found to be the case for an equatorial canal of moderate depth encircling the earth. Again, if a canal, bounded at each end, be so shallow that a wave-length (λ) extends through only a few degrees of a great circle, then even if its length approximates to λ the tides are obviously small because the tidal forces act very nearly alike on both halves, while the particles move in opposite directions in the two halves. Results like these contrasted with those obtained from observing the tides of the oceans lead to the belief that, as a rule, the ocean tides as we know them are so great that they can be produced only by successive actions of the tidal forces upon oscillating systems each having, as free period, approximately the period of the forces, and each perfect enough to preserve the general character of its motion during several such periods were the forces to cease their action.

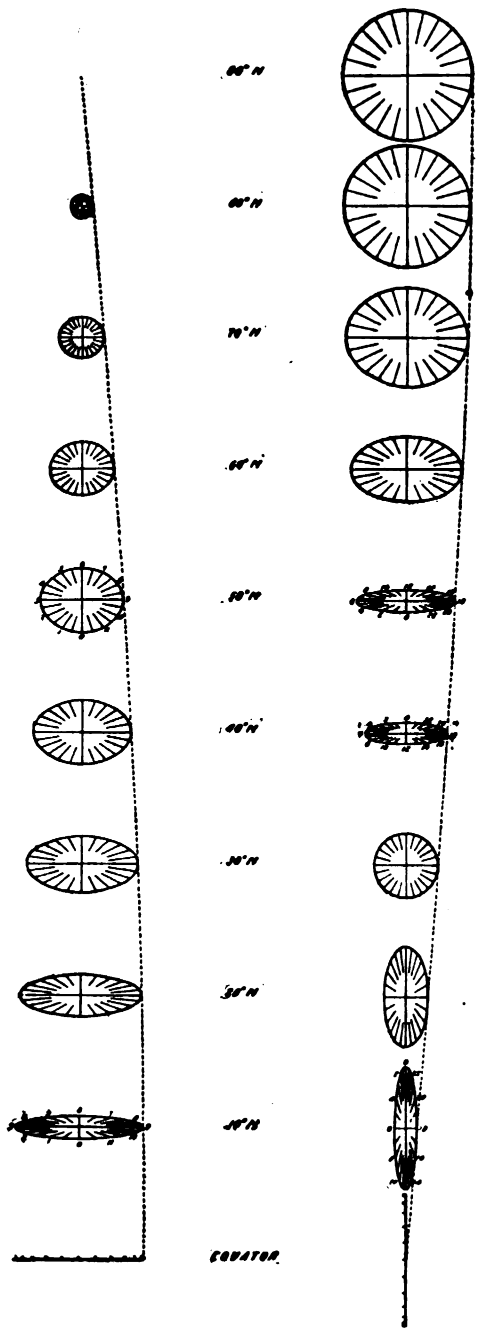

FIG. 4.— Semi-diurnal and Diurnal Tidal Forces.

That oscillations according to one of the free periods may persist for a long time can be seen in the case of some seiches; for, although probably started by a meteorological disturbance and sustained by no periodic force, yet in some harbors, straits, or bays they execute a large number of oscillations before dying out, and their periods are fairly constant in such cases. If a suitable harbor can continue to oscillate for possibly a day or two because of the inertia of the water, it is clear that an oscillation can be sustained in a large body, like a portion of one of the oceans, by a very small periodic force provided that the free period of the body is nearly equal to the period of the forces and that the boundaries are such that no great amount of energy is carried away by progressive waves or otherwise.

Suppose the oceans by reason of their depths and the configuration of shore lines to contain several. such systems whose free periods are nearly the periods of the tidal forces. These systems generally consist of still more simple sheets having like periods and which may be styled «areas.» The times of tide can be found by means of the following rule:

If to the particles of water in a given oscillating system, each area of uniform depth, and wherein the resistances are proportional to the velocities of the particles, a series of simple harmonic forces having for period the free period of the body of water be applied, and a permanent state established, then must the time of elongation be simultaneous with the time when the virtual work of the external periodic forces upon the system becomes zero.

The forces in various parts of the system and at various times or hours are those of Fig. 4. projected upon the lines of motion of the particles. The virtual displacements are the same at each assumed hour, but differ in different parts of the system.

9. Cotidal Lines.—Although the cotidal lines in the ocean are generally real and distinct, they seldom indicate the progression of a wave at the rate due to depth; such progressions, however, exist in many shallow arms of the sea, particularly in tidal rivers. Because the principal ocean tides are due chiefly to stationary oscillations, as has just been pointed out, we may expect to find extensive regions characterized throughout by nearly simultaneous tides. For that portion of the Atlantic Coast of America extending from Rhode Island to the Bahamas and Haiti, high water occurs almost simultaneously. The same is true for southeastern Alaska and the Gulf of Alaska; for the Pacific Coast of Central America, and for the eastern coast of the Philippines. The time of tide changes but little along the Atlantic Coast of Morocco and Portugal. In localities like these the rise and fall amounts to several feet even off shore and in deep water.

The Arctic Ocean is characterized by progressive tides of small range derived from the Atlantic Ocean.

In the oceans, in certain arms of the sea, and in certain lakes are to be found a considerable number of no-tide points due to various causes. From a point of this kind radiate all cotidal lines belonging to a tidal period; and so these lines, or the tide which they represent, are there said to be «amphidromic.»

Excluding lakes and seas not communicating tidally with the ocean, and considering only the semi-daily tides, about 25 no-tide points can be enumerated; a large percentage of these are to be found in straits and sounds.

A lake whose longest free period of oscillation is several times less than the period of the tidal forces will experience equilibrium tides and possess a no-tide point situated at the centre of gravity of the surface of the lake. The sequence of the cotidal lines about the point will be the same as that of the tidal forces. (Fig. 4). For semi-daily tides the numbers will increase in the clockwise or counter-clockwise sense according as the point lies in north or south latitude.

In a strait or sound a nodal line is reduced to a no-tide point through the deflecting force described in § 6; around such a point the sequence of the tide is the reverse of that of the forces. If a no-tide point is due to the overlapping of two systems, the sequence depends upon the tidal hours of the systems.

10. Peculiarities of Tides.—The distance between the Antarctic Continent and Australia being more nearly equal to the half length of a solar wave than of a lunar, causes the solar wave to be comparatively large along the southern coast of Australia. The same is true, but in a lesser degree, for the region between the Antarctic Continent and South Africa. The distance from the Antarctic Continent to the Atlantic Coast of the United States being a little more than one and one-half lunar wave-lengths causes the ratio of the solar to the lunar wave to be comparatively small along this coast. If the ocean oscillate differently for different constituents, we can readily see reasons for considerable differences of epoch and so for remarkable «ages» of the tides.

If a tidal river be so shallow that the range of tide is a considerable fraction of the depth, ordinary wave-like oscillations of the water are no longer possible. The result is that as the wave progresses, the duration of the rise will be shortened and that of the fall lengthened. An extreme case results in a phenomenon called a *bore* — an advancing wall of water, which may be several feet in height, flowing up the bed of a river. A bore (q.v.) occurs in the Petitcodiac River, an affluent of the Bay of Fundy, its height at Moncton being three or four feet. Bores occur in several of the rivers of India, in several of western Europe, in the Amazon River, in the Tsien-tang Kiang and in Turnagain Arm, Alaska. Various other peculiarities in the shape of the wave are due to the shallowness of the water. A much contracted entrance to a bay not only reduces the range within, but alters the shape of the wave.

On the other hand, the range may increase as the tide passes up a funnel-shaped bay or estuary, and especially may this be the case when the bay has a large stationary oscillation related to the waters outside. The Bay of Fundy has at its head a spring range of nearly 50 feet, which fact depends upon both of these circumstances. But the large tides in Bristol Channel, England, and in Bristol Bay, Alaska, are due chiefly to the contracting and shoaling of these bodies.

As a rule strong tidal currents occur in straits, tidal rivers, over shoals, and off capes.

Along the open coast and in the ocean at large, tidal currents generally set successively in all directions, the motion being elliptically harmonic or nearly so. This horizontal motion having two degrees of freedom is much harder to specify than is the tide, or motion defined by the rise and fall of the surface. Points at which the velocity ellipses or hydographs become circles may be styled «circular points.»

11. Tides in the Earth's Crust.— By these are meant the rise and fall experienced by the surface of the apparently solid earth due primarily to the tide-producing forces of the moon and sun acting upon the earth's crust and all matter within.

With the exception of § 5, we have made no mention of the attraction of the tidally disturbed waters upon themselves because the density of water is only 2/11 that of the «solid» earth, and the depth of the ocean is but a small fraction of the earth's radius. In the production of body tides not only is the direct disturbing action of the tidal forces involved, but also the attraction of the matter, however, disturbed upon itself.

Let a_g denote the rise and fall of the ocean's surface as measured from the earth's centre and expressed in terms of the earth's radius, a_e the rise and fall of the surface of the «solid» earth similarly measured; then the actually observed rise and fall of the waters surface relatively to the land is $a_g - a_e = m$. The value of a_e is required. From theoretical considerations of the direct and indirect effect of the tidal forces,

$$a_e = k_e a_g = \frac{k_e a}{1 - k_c k_e}$$

where a denotes the range of the equilibrium tide in an ocean of small density covering the earth, due to the direct action of the tidal forces; k_e and k_c are two moduli depending respectively upon the elasticity and internal constitution of the earth; $k_e a$ denotes the range of the deformation in the surface of the «solid» earth due to the direct action of the tidal forces.

Assuming that the day has not altered in length since the earth was in a fluid state, or when $k_e = 1$, we have observed ellipticity of meridian $= \frac{1}{1-k_e} x$ ellipticity due directly to diurnal rotation. That is,

$$\frac{1}{297} = \frac{1}{1-k_c} \cdot \frac{1}{578};$$

whence $k_c = 0.486.1$

The value of k_e can be determined by comparing the observed period of the movement of the axis of figure about the axis of rotation with the period of free precession (or 305 sidereal days) obtained upon the assumption of a rigid earth.

Another determination of k_e is obtained by comparing the observed range of the monthly or fortnightly tide with the equilibrium range due to the direct action of the tidal forces. This ratio or m/a is found to be about ⅔. Daily or semi-daily tides in a deep lake or in a buried pipe also give a determination of m/a. The actual deviation of the vertical from its mean position, due to the daily or semi-daily tidal forces, and obtained by means of a horizontal pendulum, gives, upon comparison with the direct theoretical deviation, another determination of the ratio m/a. If k_c be taken as 0.5, and m as ⅔, then by the above equation,

$k_e = 0.5$ and $a_e = \frac{2}{3} a$; that is, the actual rise and fall of the surface of the «solid» earth is about $\frac{2}{3}$ of the rise and fall of the surface of an ocean of small density surrounding a rigid sphere. If the latter be 1.8 feet (§ 5), the former will be about 1.2 feet. [This mode of treatment is due to Ch. Lallemand.]

12. Observation of Tides.— The height of the tide, or water surface, at any given time can be directly observed upon a graduated fixed staff if the water be tolerably smooth. A long box fixed in a vertical position, having a small opening near the lower end, and usually supplied with a float, enables one to observe during stormy weather as well. In some instances only the times and heights of the high and low waters are observed and recorded. But a more satisfactory record is obtained by reading the gauge at regular intervals one hour or one-half hour apart.

Automatic or self-registering gauges are usually constructed for drawing a continuous curve. Such a gauge consists of a float and box, a time-piece, and some form of recording apparatus. The record from an automatic gauge can be procured with comparatively little trouble; it shows clearly the peculiarities of the tide; and it furnishes material for a thorough analysis or discussion.

The velocities and directions of tidal streams are usually ascertained by aid of a float and line or some form of current-metre. Such observations are attended with considerable difficulty because they must generally be made at some distance off shore.

13. Analysis of Observations.— If only the high and low waters are to be treated, they are first referred to the moon's transit for obtaining lunitidal intervals. The ranges of tide are found at the same time. The intervals and the heights or the ranges are next classified according to certain astronomical arguments for the purpose of bringing out the corresponding tidal inequalities.

The harmonic analysis rests upon Laplace's principle of forced oscillations, namely:

The state of any system of bodies, in which the primitive conditions of the motion have disappeared through the resistances which the motion encounters, is coperiodic with the forces acting on the system.

Here is the clue to what oscillations ought to be found in the tidal wave; for, there ought to be an oscillation corresponding to each term of the causes producing the tide. Such terms follow from the development of the tide producing potentials of the moon and sun. Their arguments and «speeds» involve simple combinations of the mean longitudes and mean motions of the local meridian projected on the celestial sphere, the moon, the sun, the equinox, the lunar perigee, the solar perigee, and the moon's node. There are three principal classes of terms: semi-diurnal, diurnal and long-period.

If for a sufficiently long time the observation curve be read and summed with reference to any constituent or component defined by its «speed,» the effects of the other components will gradually disappear and the final sums will pertain only to the one sought (including, of course, its harmonics). To avoid reading the curve with reference to each component, the tabulation according to mean solar time is made to serve for all. This is done by distributing the (solar) hourly heights among the component hours as nearly as possible. Tables showing the proper distribution of hourly heights as well as blank forms into which the heights are to be copied have been used quite extensively. For about 30 years perforated sheets, known as stencils, have been used for pointing out which hourly heights of the tabulation go with the various hours of the component sought. These enable one to dispense with the labor involved in copying into the various forms. Some years ago a set of movable scales or strips was devised upon which the hourly heights are copied once for all summations. Several machines have been devised or constructed for facilitating the work of analysis, but they have not yet come into actual use.

Through the 24 partial sums or means finally obtained for a given component (and its harmonics) imagine a curve to be drawn. It may be represented by a Fourier series whose coefficients and initial phases can be found without difficulty. Then by taking the initial phases from the proper astronomical arguments for that time, the required epochs will be obtained.

14. Prediction of Tides.— At most ports the time of tide can be roughly predicted by adding to the time of the moon's transit, upper or lower, the average value of the lunitidal interval or «establishment» for the port. Where the diurnal wave is not large, the height of high water above mean sea-level is roughly equal to half of the mean range of tide; the low water is as much below this plane or datum.

Where great refinement is desired, the process just referred to involves much labor, and can best be carried out after a tolerably complete harmonic analysis has been made. This done we have only to add together a series of cosine terms for obtaining the height of the surface of the sea at any given time. But the number of these terms is so great that such a computation would soon become laborious, since it must be made for many assumed times in each day's predictions. Several predicting instruments have been designed or constructed. Generally speaking, the object of such an instrument or machine is to produce simple harmonic motions of suitable periods, phase and amplitude and to combine the results into one compound wave, or perhaps into two compound waves. The simplest form may be described thus: Upon one or more shafts, driven by hand or by clockwork, are fixed a number of wheels which mesh into other wheels, causing the latter (or wheels moved by them) to revolve with angular velocities having given ratios to the angular velocities of the shafts. These ratios are taken, as nearly as possible, proportional to the speeds of particular tidal components. Rigidly connected to these wheels are cranks carrying pulleys, or pins working in slots and which impart to vertical rods carrying pulleys rectilineal harmonic motions. At one end of the machine a chain or flexible wire is made fast; thence it is laid alternately over and under the pulleys. Near the other end of the chain or wire is attached a marking point which, when moved transversely to the line of motion of the paper roll, traces the tidal curve. It is evident that the machine continually sums a series of cosine terms.

If the instrument include a set of cranks at right angles to those giving the tide curve, together with pulleys and a summation chain or wire, the movement of a point on the chain (taking the place of the tracing point) across a fixed line or mark, corresponding to mean sea-level, will show the time when a high or low water occurs.

The original and simplest form of instrument is that due to Kelvin. The one designed by Ferrel is somewhat complicated, inasmuch as it separates out the principal lunar component. It was used in the office of the United States Coast and Geodetic Survey for about 30 years. Its chief advantage consists in indicating upon its face the times and heights of the tides. The office has recently completed and put in operation a machine which besides tracing a curve, as does Kelvin's indicates upon its face the times and heights of the tides,— the times becoming known through the additional mechanism just described.

Bibliography.— Newton, 'Principia' (Bk. I, Prop. 66; Bk. III, Props. 24, 36 and 67); Laplace, 'Traité de Mécanique Céleste' (Bks. IV and XIII); Sir John W. Lubbock, Rev. Wm. Whewell, and others in the 'Philosophical Transactions' (1830 et seq.); Airy, 'Tides and Waves' (Enc. Met.); Thomson and Tait, 'Natural Philosophy' (2d ed., §§ 804–848 and Appendix B); Ferrel, 'Tidal Researches' (United State Coast Survey); Lamb, 'Hydrodynamics'; Darwin, 'The Tides and Kindred Phenomena in the Solar System'; «Scientific Papers»; Maurice Lévy, 'Leçons sur la Théorie des Maréss'; H. Poincaré 'Leçons de Mécanique Céleste'; United States Coast and Geodetic Survey Reports; Appendixes by A. D. Bache, Chas. A. Schott, Henry Mitchell, Wm. Ferrel, R. A. Harris and others.

Annual.— Tide Tables issued by the governments of Great Britain, France, Germany, the United States and other countries.

ROLLIN A. HARRIS,
Author of 'Manual of Tides.'

TIDEWATER, arms of the sea, bays, creeks and rivers where the tide ebbs and flows are public, and all persons may use the same for the purpose of navigation and fishing, unless restrained by law; in such waters the tide must actually ebb and flow. It is the rise and fall of the water, and not the proportion of salt water to fresh that determines whether or not the particular portion of a stream is within tidewater; the same determination applies to small streams as well as large ones. Open sea is the property of all nations; the rights and privileges therein, if any, being restricted to a specified distance from the shore — generally three miles. In the United States the titles to tidewaters and lands are vested in the States abutting thereon, or of its citizens, but are subject, however, to the constitutional rights of the United States. The Congress of the United States, under its power to regulate commerce, has the control of all navigable waters, and for such purposes they are the public property of the nation and subject to legislation; the test of navigability being whether or no the waters form a continued highway over which commerce may be carried on.

At various bathing beaches where the ocean frontage has become very valuable, private parties and owners of bathing pavilions often occupy the region between high and low water, and shut out or try to shut the public therefrom. This they have no right to do. Neither has any municipality a right to construct a bridge over a tidewater stream so as to obstruct navigation, which is the right of the public. The mariner also has the right to land wherever the shore connects with a public highway. Owners of land or a tidal shore have a right to build a pier or wharf for convenience in landing and embarking, but they must allow passage along the tide line, and must not block navigation. The right of fishing in tidal waters cannot be stopped by any adjacent landowner, though it is subject to local enactment for the protection of fish. Oyster beds often lie in tidal waters, and have been the subject of much dispute. See RIPARIAN RIGHTS.

TIECK, Johann Ludwig, German dramatist and novelist of the Romantic School, known also under the pseudonyms, PETER LEBRECHT and GOTTLIEB FÄRBER: b. Berlin, 31 May 1773; d. Berlin, 28 April 1853. He was of lowly origin, his father being a poor ropemaker. From 1782 to 1792 he attended the Friedrichswerder Gymnasium in his native city, coming under the influence of teachers with literary inclinations (Rambach, A. F. Bernhardi), and beginning a friendship with Wackenroder that was to last until the latter's death. His wish to become an actor was denied by his parents, and he was obliged to go to the University of Halle (1792) to study theology and philology, and to the University of Göttingen (1792–95), where he took up modern philology and literature. In 1797 he wrote cheap stories for the apostle of enlightenment at Berlin, Nicolai, and, during a short stay in Hamburg, made the acquaintance of Klopstock and Schröder, and became engaged to Miss Alberti (d. 1837), whom he married the following year. He became thoroughly well acquainted with all the members of the early romantic school in Germany, in 1798–1800, while living in the university town of Jena (the two Schlegels, Novalis, Fichte, Brentano, Gries), as well as with Goethe and Schiller, who were living at Weimar, a short walk from Jena. For 15 years, beginning 1802, Tieck and his wife lived, with few interruptions, on the Ziebingen estate (near Frankfort on the Oder) of his intimate friend, Wilhelm von Burgsdorff (really the property of the latter's uncle, Count Finkenstein). He traveled in Italy (1804–06) with his sister Sofie (1755–1833), who had married Bernhardi, and in various libraries on this journey he became acquainted with important manuscripts of mediæval German poems ('Nibelungenlied,' 'König Rother,' etc.). In 1819 he settled in Dresden, where he became (1825) manager of the Court Theatre, with the title of *Hofrat.* The last years of his life were spent chiefly at Berlin, to which city he was called (1840) by King Frederick William IV of Prussia, who greatly admired his work, and who granted him an annual pension of 3,000 thalers. Together with Friedrich Schlegel (q.v.) and August Wilhelm Schlegel (q.v.), Tieck was the founder of the Romantic School in Germany, and while he was not the most profound or original writer of this movement, he certainly was its most versatile member. His connection with C. A. Nicolai did not last long, and Tieck's first independent venture in literature was the romance of wild adventure, 'William Lovell' (Berlin 1795–96), an imitation of Réstif de la Bretonne (q.v.). In 1797, in his 'Volksmärchen,' appeared the satirical comedy 'Der gestiefelte Kater' ("Puss in Boots"), an outrageous and ingenious burlesque on the taste of the Berlin public in dramatic literature, which is not unlike some of the comedies of George Bernard Shaw. But Tieck's romantic productions begin with his collaboration with Wackenroder on the 'Herzensergiessungen eines kunstliebenden Klosterbruders' (1797) and 'Franz Sternbalds Wanderungen' (1799), romances of artistic journeys through Germany, which first opened the eyes of Germans to the beauties of the architecture and the spirit of the Middle Ages; also 'Phantasien über die Kunst' (Hamburg 1799), in which the same views are expressed in the form of criticism. His art demands are best embodied in a number of plays appearing from 1799 to 1804 ('Prinz Zerbino,' 'Der blonde Eckbert,' 'Genoveva,' 'Melusine,' 'Kaiser Octavianus'), in which Tieck consciously pursues a tendency new in literature, namely, the emphasis on feeling, longing and mood, and the attempt to bring about a different attitude toward art as well as toward the past (particularly the Middle Ages). Tieck had considerable literary scholarship, aside from his productive work, and he was the editor of a number of old German poems and the translator of 'Don Quixote' and Shakespeare (in the latter task he was aided by August Wilhelm Schlegel and by his own daughter Dorothea, 1799–1841). In the creative field his best work is in three departments: fantastic plays, 'Phantasus' (Berlin 1812–16); his poems (Dresden 1821–23); and his short stories (*novellen*), whose literary influence is by no means limited to their own day. The best of the latter are 'Der Aufruhr in den Cevennen' (first published, Berlin 1826); 'Der Gelehrte' (1828); 'Der Hexensabbath' (1832); 'Die Vogelscheuche' (1835), and 'Des Lebens Ueberfluss' (1839). He was less successful in his long two-volume novel, 'Vittoria Accorombona' (Breslau 1840). For editions of his works consult 'Novellen' (7 vols., Berlin 1823–28); 'Gesammelte Novellen' (14 vols., Berlin 1835–42); 'Ausgewählte Werke' (Stuttgart 1886–88); 'Ausgewählte Werke,' with biography, by Witkowski (Stuttgart 1903); 'Tiecks Werke, Auswahl' (6 vols., Berlin 1908); Tieck's correspondence with various persons (Raumer, Solger, Bernhardi) has also been published in separate editions. Translations of 'Puss in Boots,' 'Fair Eckbert,' and 'The Elves' are given in 'German Classics' (Vol. IV, New York 1913). Consult also Köpke, Rudolf, 'Ludwig Tieck' (2 vols., Leipzig 1855); Hoffmann, J. L., 'Ludwig Tieck' (Nürnberg 1856); Kaiser, Oskar, 'Der Dualismus Tiecks als Dramatiker und Dramaturg' (Leipzig 1885); Fischer, L. H., 'Aus Berlins Vergangenheit' (Berlin 1891); Danton, H. G., 'The Nature Sense in the Poetry of Ludwig Tieck' (New York 1906); Marchard, L., 'Les deux sources du Sternbald' (in *Revue germanique*, Vol. II, p. 522); Hemmer, H., 'Die Anfänge Ludwig Tiecks' (Strassburg 1908).

JACOB WITTMER HARTMANN.

TIED ISLANDS. See SHORE LINE.

TIEDEMANN, tē'dĕ-män, **Christopher Gustavus,** American legal writer: b. Charleston, S. C., 16 July 1857; d. Buffalo, N. Y., 25 Aug. 1903. He was graduated from the College of Charleston in 1876 and from Columbia Law School in 1879 and was professor of law for 10 years in the University of Missouri and six in New York University. From May 1902 he had been dean of the Buffalo Law School. Among his publications are 'The Law of Real Property' (1883); 'Limitations of Police Power' (1889); 'The Unwritten Constitution of the United States' (1890); 'State and Federal Control of Persons and Property' (1900).

TIEDEMANN, Diedrich, German philosopher: b. Bremerworde, 3 April 1748; d. Marburg, 24 Sept. 1803. He was professor of philosophy in the University of Marburg from 1776 and published 'Researches on the Origin of Languages' (1772); 'System of the Stoic Philosophy' (1777); 'The First Philosophers of Greece' (1780); 'Origin of the Magic Arts' (1787); 'Spirit of Speculative Philosophy from Thales to Berkeley' (1790–97), his principal work; 'Theætetus; or, Human Knowledge' (1794).

TIEDGE, tēd'gĕ, **Christoph August,** German poet: b. Gardelegen, Prussia, 14 Dec. 1752; d. Dresden, Saxony, 8 March 1841. He enjoys distinction as the author of 'Urania,' a lyric-didactic poem (1800), and 'Mirror for Women.' He also wrote 'Wanderings through Life's Market,' and 'Elegies.' His admirers have been many, and his poetry has sometimes been compared with that of Cowper. The year following his death the Tiedge Foundation was established for the purpose of assisting poets and artists or their widows and children, and also for the care of the poet's grave. Consult Kern, 'Beiträge zu einer Charakteristik des Dichters Tiedge' (Berlin 1896).

TIEFLAND. See MARTA OF THE LOWLANDS.

TIEGHEM, tē-gäṅ, **Philippe-Eduard Léon van,** French botanist: b. Bailleul, 19 April 1839; d. Paris, 30 April 1914. He was maitre de conferences at l'École Normale (1864); member of the Academy of Sciences (1877); professor of botany at the Museum (1879); professor of the Institute National Agronomique (1900). He greatly advanced the knowledge of the anatomy of the vegetable kingdom and proposed a new classification of the vegetable world. He established divisions among the Phanerogamia according to the character of the ovule. He wrote 'Traité de botanique' (Paris 1891); 'Elements de botanique' (Paris 1898), besides numerous works on his studies of myxomycetes, ascomycetes, bacteria, fermentation, etc. His articles are numerous in the *Journal de Botanique* and *Annales des Sciences Naturelles*.

TIELE, tē'lĕ, **Cornelis Petrus,** Dutch writer on comparative religion: b. Leyden, 16 Dec. 1830; d. there, 14 Jan. 1902. He was educated at Leyden and Amsterdam, in 1853 became pastor of the Remonstrant congregation at Moordrecht, and in 1856 removed to Rotterdam, where he became closely associated with Albert Réville (q.v.), whose liberalism in theological matters he fully shared. He was director of the Remonstrant theological seminary at Leyden from 1873 till his death, and during 1877–1901 held the professorship of the history and philosophy of religion in the University of Leyden, a chair specially created for him. In 1896–98 he delivered the Gifford lectures in the University of Edinburgh, published as 'Elements of the Science of Religion' (2 vols., 1897–99). He was one of the pioneers in the study of comparative and historical religion, and among his chief works are 'The Religion of Zoroaster' (1864); 'Comparative History of the Egyptian and Semitic Religions' (1869–72); 'History of Religion in Antiquity' (1892–96; 2d ed., 1901); 'Western Asia in the Light of Most Recent Discovery' (1894). Consult Jordan, L. H., 'Comparative Religion' (New York 1905).

TIEMANNITE, native mercuric selenide. It is a gray, metallic mineral of high specific gravity, 8.2 to 8.5; and a hardness of 2.5. It occurs massive with chalcopyrite in the Harz Mountains in Germany, and in choice isometric-tetrahedral crystals at Marysvale, Utah.

TIENTSIN, tē-ĕn'tsĕn', China, a city and treaty port in the province of Chili, situated on the Peiho River, 70 miles by water from its mouth in the Gulf of Pechili. The old city is a square surrounded by walls and ditches and traversed by broad, straight streets. Two miles to the south lies the European quarter. Tientsin is southeast of Peking with which it is connected by rail and also with the Manchurian Railroad. It is the river port of the capital, although large vessels cannot ascend the river. Its position at the northern terminus of the Grand Imperial Canal, however, makes it one of the principal trade centres of the empire. The total volume of imports amounted (1916) to about $59,017,093, of which more than one-third represented imports from foreign countries; exports totaled $34,097,085. Tientsin was besieged by a detachment of Taiping rebels in 1853. The Taiping army was on the way to Peking, and the defeat at Tientsin saved the capital from attack. In June 1900, during the Boxer troubles, Tientsin was occupied, after severe fighting, by the allied troops. Pop. estimated at 800,000. See CHINA.

TIEPOLO, tē-ā'pō-lō, **Giovanni Battista**, («IL TIEPOLETTO»), Italian painter: b. San Piero di Castello, near Venice, 5 April 1696; d. Madrid, 22 March 1770. He was a pupil of Gregory Lazzarini and followed as closely as he could in the footsteps of Paul Veronese, whose style he reproduced in numerous wall and ceiling pictures. Many churches and palaces of Venice were decorated by his hand. In 1750 he was summoned to Würzburg, where for three years he worked in the archbishop's palace on the wall paintings in fresco 'Olympus,' 'Four Quarters of the Earth,' and 'Life of Frederick Barbarossa.' In 1754 he returned to Venice as director of the Art Academy. In 1763 King Charles III summoned him to Spain to decorate the royal palace. Here he painted 'Smithy of Vulcan,' 'Apotheosis of Spain' and the ceiling frescoes 'Spain and her Provinces.' He was the last great master of the Venetian school. His coloring was superb, and his designs spiritual and expressive even when the drawing was incorrect. Among Tiepolo's easel pictures may be named 'Christ in the Garden'; 'Adoration of the Kings' (Imperial Gallery, Vienna); 'After the Bath' (Berlin Museum); 'Immaculate Conception' (Vicenza and Madrid). Many of his altar pieces are in the churches of Venice. A few of his paintings are in the Metropolitan Museum, New York. Consult Chennevières, H. de, 'Les Tiepolo' (Paris 1898); Gheltof, Urbanide, 'Tiepolo in Ispagna' (Venice 1881); Molmenti, P. G., 'G. B. Tiepolo' (Milan 1910); 'Masters in Art' (Vol. VI, Boston 1907).

TIERNAN, Frances Fisher («CHRISTIAN REID»), American novelist: b. Salisbury, N. C., 5 July 1846. Among her many works are 'Valerie Aylmer' (1870); 'Morton House' (1871); 'Nina's Atonement' (1873); 'A Daughter of Bohemia' (1873); 'A Question of Honor' (1875); 'The Land of the Sky,' a volume of travel (1875); 'Bonny Kate' (1878); 'Hearts of Steel' (1882); 'Miss Churchill' (1887); 'Philip's Restitution' (1888); 'Armine' (1884); 'The Land of the Sun' (1894); 'The Picture of Las Cruces' (1895); 'The Man of the Family' (1898); 'Weighed in the Balance' (1901); 'A Daughter of the Sierra' (1903); 'Princess Nadino' (1908); 'The Light of the Vision' (1912); 'The Daughter of a Star' (1913); 'A Far-Away Princess' (1914); 'The Secret Bequest' (1915). In 1909 Mrs. Tiernan was awarded the Lætare Medal by the University of Notre Dame.

TIERRA DEL FUEGO, tē-ĕr'rā dĕl fwā'-gō, an archipelago at the extreme south of South America, separated from the mainland by the Strait of Magellan which forms its boundary on the north and northwest, while the Atlantic Ocean bounds it on the east and the Pacific Ocean on the southwest; total area about 19,299 square miles. Politically, it is divided into two parts, each of which will be briefly described. (1) The western part, the area of which is 11,000 square miles, belongs to Chile and is included in the extensive Chilean territory of Magallanes, whose capital, the little town of Punta Arenas, stands on the western (mainland) shores of the strait, and is a port of call for steamships of some European and Australian lines (Hamburg to Callao, etc.). The lands belong to the state. (2) The eastern part, area 8,299 square miles and population about 1,000 whites and several thousand Indians, belongs to Argentina and forms a territory of that republic, its capital being Ushuaia. Of this region about 1,000,000 acres have passed into private ownership and only a small proportion is rented. In the north there are fertile valleys and roads connecting the villages lead through Chilean territory to ports on the southern coast of the Strait of Magellan. The interior is mountainous or hilly, but well adapted to stock-raising. «The climate of this region,» it is said, «though cold, is not severe, inasmuch as the mean temperature, maximum and minimum, as taken during several years, is $+ 5°$ C. and $— 10°$ C., respectively. Calm days are frequent in winter. Rain increases in the autumn, and in the summer dry winds from the southwest and west prevail, and occasionally are of terrific force.» (Consult 'Argentine Republic: a Geographical Sketch,' issued by the International Bureau of

American Republics, Washington 1903). There are no navigable rivers, but many streams of moderate size and a number of lagoons. The oldest and in some respects still the most interesting description of the region of the famous strait (of which both shores are now held by Chile) is that one written by Anthony Pigafetta, who accompanied Magellan and told of what they saw in October 1520, mentioning the characteristic storms, the «very great and high mountains covered with snow» surrounding the strait, and finally saying: «In it we found at every half league a good port and place for anchoring, good waters, wood all of cedar and fish like sardines, missiglioni, and a very sweet herb named appio (celery). There is also some of the same kind which is bitter. This herb grows near the springs and from not finding anything else we ate of it for several days. I think that there is not in the world a more beautiful country or a better strait than this one.» Pigafetta's sketch map of Magellan's Strait proves that he regarded Tierra del Fuego as a great southern continent stretching toward the antarctic pole. Consult Lord Stanley of Alderley, 'The First Voyage Round the World,' printed for the Hakluyt Society.

TIERS-ETAT, tē-ăr-zā-tā, the third estate, a name early given in France to the free bourgeoisie, to distinguish them from the nobility and the clergy, the other two estates. The three estates together formed the états-generaux or States-General, a legislative body which might be compared to the English Parliament. The third estate became famous in the political upheaval in France at the end of the 18th century, when, in the last States-General, it claimed power equal to that of both of the other orders. In 1789 it assumed the name of the National Assembly, and by its subsequent assumption of supreme power consummated the French Revolution. See France — History from Revolution to Empire.

TIETJENS, tĕt'yĕns, or **TITIENS, Therese Johanna Alexandra,** German soprano singer of Hungarian descent: b. Hamburg, 17 July 1831; d. London, England, 3 Oct. 1877. She made her début in her native city as Lucrezia in the opera of 'Lucrezia Borgia' in 1849, and her after career was one of great success, as she not only possessed a voice of great power and purity, but was an actress of much ability likewise. She made her home in London after 1858. In 1875 she visited the United States singing in 'Don Giovanni' and other grand operas.

TIFFANY, Charles Comfort, American Protestant Episcopal clergyman: b. Baltimore, Md., 1829; d. 20 Aug. 1907. He was educated at Dickinson College, Andover Theological Seminary and the universities of Halle, Heidelberg and Berlin and took orders in the Episcopal Church in 1866. He was rector of the Church of the Atonement, New York, 1874–80, and of Zion Church there, 1880–90. He was archdeacon of New York (1893–1902). He published 'Expression in Church Architecture'; 'Modern Atheism'; 'History of the Protestant Church' (1895); 'The Prayer Book and the Christian Life' (1897).

TIFFANY, Charles Lewis, American manufacturer: b. Killingly, Conn., 15 Feb. 1812; d. New York, 18 Feb. 1902. In 1837 he began his business career in New York, where in partnership with John B. Young he opened a stationer's store, to which were added Chinese and Japanese works of art and later French jewelry. The business founded on borrowed capital of $1,000 grew rapidly, the jewelry trade soon becoming the most important. In 1848 the firm began to deal exclusively in jewels, bronzes and other articles of virtu, and to manufacture gold and silver ware. The same year when the value of the diamond was so depreciated because of the unsettled conditions in Europe, Tiffany instructed his partner, at the time being in France, to buy as many diamonds as he could. Through this venture the reputation of the house among leading diamond merchants was established. In 1851 the name became Tiffany and Company, and the firm was incorporated in 1868. Changing conditions from time to time necessitated removals farther uptown, until the business was located at the present site in 1905. Mr. Tiffany was known as the chief diamond merchant in the United States, and established branch houses, also well known in London and Paris. The standard for sterling silver, 0.925 fine, now recognized throughout the entire country, was adopted by him in 1851. He was a liberal patron of the fine arts.

TIFFANY, Louis Comfort, American artist and decorator; b. New York City, 18 Feb. 1848. In early life he evinced a strong inclination toward the fine arts; hence his parents wisely gratified his tastes and educated him for an artist. He first studied with George Inness and Samuel Coleman in New York, then with Léon Bailly in Paris. He spent five years in Europe and the Orient, and besides working in water colors and oils, devoted much of his time to the study of the decorative arts. He became interested in glass and its possibilities in the early 70's and revived the mosaic theory in the construction of colored glass windows. Believing that work executed upon this principle would give the best artistic results, but finding that the glass in the markets did not have the range of color and texture necessary to carry out his ideas, he began a series of experiments through existing glass houses, but as these failed to grasp his thoughts he established works of his own. He succeeded in producing not only many of the finest effects that were obtained in the past, but also discovered new formulas by which he could make glass unlimited in its range of color and texture. With this glass, which is known as «Tiffany favrile glass» he has not only made windows of great beauty, but also vases and different objects of artistic interest which at once commanded the admiration of the world. In 1878 he organized a company under the title of Louis C. Tiffany and Associated Artists, for the purpose of promoting the decorative arts in America and particularly the developing the making of colored-glass windows. This was the foundation of the business. The glass blowing branch was first established as the Stourbridge Glass Company, and subsequently the Tiffany Furnaces. The general manufacturing and merchandising began under the name of the Tiffany

Glass Company, which in the development and broadening of its business became the Tiffany Glass and Decorating Company and the Allied Arts Company which are now more generally known as the Tiffany Studios. One of his most notable works in mosaic is the Chancel of the Crypt in the Cathedral of Saint John the Divine in New York, executed in glass mosaisc and semi-precious stones. Another recent example is the interior decoration of the new Madison Square Presbyterian Church in New York. But while there are hundreds of churches with Tiffany windows and many of them entirely decorated by his artists, ecclesiastical work is only one of the many branches of his varied artistic achievements. In domestic decorative work his two dwellings, the city home at Madison avenue and 72d street, New York, and «Laurelton,» his country house at Oyster Bay, L. I., are varied examples of his individuality and taste. Many of the most notable residences, university halls, hotels, theatres and other buildings in New York, Boston, Chicago and other large centres have been decorated by his art workers. Louis C. Tiffany is perhaps more widely known through his work in glass, mosaics and interior decorations, as these naturally appeal to the popular taste and attract attention by their exposure to public view. His genius, however, has not been restricted even to these varied fields, but he has constantly sought employment wherever artistic feeling could give expression. His studies in chemistry and his exhaustive laboratory work revealed new possibilities beyond the realms of glass. He has worked successfully in tapestry, rugs and other materials, pottery, metallic lustres, enamels and in later years he has given much thought to art jewelry and silverware, all of which, however, have not weaned him from his early love of the brush. He was from the first, and is to-day, a painter and works with his brush not only in his studios in town and country, but also on his annual trips abroad. After one of his winter sojourns in Egypt he brought home in 1906 over 23 water colors which he executed while sailing in his dahabiah on the Nile. His water colors and pictures in oil are frequently seen in the galleries of the art clubs and at other exhibitions. Among his principal canvases are 'Dock Scene' (1869); 'Spring' (1874); 'Wading at Seabright, N. J.' (1876); 'Street Scene in Tangiers' (1876); 'Study of Quimper, Brittany' (1877); 'Duane Street, New York' (1878); 'In the Fields at Irvington, N. Y.' (1879); 'The Cobblers at Boufarick' (1888); 'Feeding the Flamingoes' (1888); 'Church in Morlaix, Brittany' (1890); 'Market Day at Nuremberg' (1892); 'Street Scene in Algiers' (1895); 'Algerian Shops' (1895). Mr. Tiffany is art director of the Tiffany Studios, president and art director of the Tiffany Furnaces and vice-president and art director of Tiffany and Company, the jewelry house founded by his father. He was made a member of the Water-Color Society in 1870, an associate of the National Academy of Design in 1871 and an academician in 1880. He is also a member of the Society of American Artists, the Architectural League, the New York Society of Fine Arts, the Société Nationale des Beaux Arts of Paris and the Imperial Art Society of Japan. In 1900 he received a gold medal and the decoration of Chevalier of the Legion of Honor from the French government, in 1901 a gold medal at the Dresden Exposition, in 1902 a special diploma from the Turin Exposition and in 1903 Yale University conferred upon him the degree of A.M. In addition to these honors and decorations the art work, notably in glass, made under his direction received numerous awards at international expositions. Consult 'The Art Work of Louis C. Tiffany' (Garden City, N. Y., 1914).

TIFFANYITE. Certain bluish or bluish-white diamonds, principally from Brazil, although a few have been found in India and South Africa, phosphoresce for a considerable time after having been exposed to bright sunlight, electric light, or other brilliant rays. This property results from the inclusion in the diamond of a hydrocarbon or a rare earth, and for this class of diamonds the New York Academy of Sciences (1890) has given it the name «tiffanyite.»

TIFFIN, Edward, American physician, preacher and politician: b. Carlisle, England, 19 June 1776; d. Chillicothe, Ohio, 9 Aug. 1829. About 1786 he went to Charlestown, Va., and in 1789 was graduated in medicine at the University of Pennsylvania. Three years later he became a local preacher in the Methodist Church, likewise studying law and continuing the practice of medicine. About 1797 he removed to Chillicothe, in what was then the Northwest Territory, was elected to the Territorial legislature and in 1799 was speaker. He was chosen president of the convention which framed the State constitution (1802), and became first governor (1803–07) of Ohio. The town of Tiffin in that State was named for him. He arrested the Burr-Blennerhassett expedition in 1805. (See BLENNERHASSETT, HARMAN; BURR, AARON). He was a United States senator in 1807–09, resigned in the latter year to assume the speakership of the Ohio legislature. He was the first commissioner of the General Land Office (1812), and at the burning of the National Capitol by the British in 1814 saved the papers from destruction. In 1815 he was made surveyor-general of the Northwest Territory and continued in that office almost until the end of his life.

TIFFIN, Ohio, city, county-seat of Seneca County, on the Sandusky River and on the Baltimore and Ohio, the Pennsylvania and the Cleveland, Cincinnati, Chicago and Saint Louis railroads, about 80 miles north by west of Columbus, the State capital and 40 miles southeast of Toledo. It was settled in 1817 by Erastus Bowe, and incorporated in 1835. In 1836 it was chartered as a city. It is the commercial and industrial centre for a large portion of the country, in which are many fine farms. In the vicinity of Tiffin are deposits of clay and glass-sand. The chief manufacturing establishments of the city are machine shops, glass works, potteries, wagon and carriage works, motor truck works, glove and mitten works, candy factories, breweries, iron works, planing mills, emery-wheel works, flour mills and furniture factory. There are about 5,000 employees in the city's manufactories. The principal public buildings are the county courthouse, the municipal buildings, the churches and schools. There are 16 churches, representing 10 denominations, and

Saint Francis Hospital and Home. The educational institutions are Heidelberg University (Reformed), opened in 1850 (nearly 650 students in 1915), Ursuline College, public and parish schools and two libraries. Tiffin is the location of the national home of the Junior Order of United American Mechanics, containing about 400 children. The four banks have a combined capital of $500,000; the annual business done through the banks amounts to over $3,000,000. The government is administered under a board of public safety, board of public service and council of seven members elected by wards and at large. Pop. 14,256.

TIFLIS, tĭf'lēs', Russia, the capital of the government of Tiflis in the general government of Caucasia (see TRANSCAUCASIA), situated at the southern base of the Caucasus about midway between the Black and the Caspian seas. It is picturesquely built on terraces rising from the valley of the Kur, and surrounded by orchards and vineyards. Some walls and towers of the old fortifications remain, and there are several parks and a botanical garden. Among the numerous churches the most interesting is the cathedral of Zion, dating in part from the 5th century. Other notable buildings are the palace of the governor-general, the Caucasian museum and library. The educational institutions include nearly a dozen high schools, besides numerous technical schools, one of the foremost of which is the finely equipped school of commerce. The chief industries are the manufacture of leather, oil, silk, woolens, carpets and tobacco. There is also a cotton-mill and several breweries and distilleries. Commerce has declined somewhat, though the city is connected by rail with both the Black and the Caspian Sea. Pop. 327,800.

TIGER, the largest and most admirable of the cats (*Felis tigris*). In size and power it surpasses the lion, as it does in beauty, and expresses the highest type of feline structure. (See FELIDÆ). The ground color of the body is a bright tawny yellow, bearing black stripes running at right angles with the general axis of the body and limbs. The under parts and inner aspect of the limbs are white, as also are the throat and chest. On these white parts the stripes are lighter, and gradually merge into the white color. The tail is not tufted at its extremity, and is usually of lighter hue than the body, with dark rings. White or albino varieties of the tiger have been found, as also black ones. The maximum length, including the tail, is about 11 feet, and the largest weigh about 500 pounds. The tiger attains its full development in India, the Bengal variety being the largest and most typical; but it also occurs in southern Siberia, Turkestan, Persia, Java, Sumatra, China and Japan, encountering a range of climate from tropical to sub-arctic conditions. In habits these animals are far more active and agile than the lion, and exhibit a large amount of fierce cunning. They generally select the neighborhood of water-courses as their habitat, and spring upon the animals that approach to drink, then drag them to a more retired spot to be devoured. The march of the animal through the thick brushwood of the jungles in which it lives is noiseless and stealthy, and it appears rather to avoid than to court danger, although, when brought to bay, no animal presents a fiercer front than the tiger. Where deer, antelopes and wild hogs are abundant, domestic animals are comparatively safe, but otherwise the tiger is ready enough to prey on the latter. When pressed by hunger or enfeebled by age and incapable of dealing with larger prey, like buffaloes, the tiger prowls around villages, and, having once tasted human flesh, becomes a confirmed cattle-lifter and man-eater, sometimes causing the temporary abandonment of a large district by the terror-stricken inhabitants; and in several historic instances districts of country in southern India, Indo-China and the adjacent islands have been deserted premanently because so infested with tigers harbored by neighboring swamps and jungles. The number of persons killed by tigers each year in India averages about 930, mostly in Bengal, Madras, Central Provinces, Assam and Burma. About 32,000 head of cattle are also killed annually in India by tigers.

The natives destroy tigers by traps, pitfalls, spring-guns and poisoned arrows, but the orthodox method of keeping down their numbers as pursued by Europeans is to employ natives to beat the bush while the game, when started, is shot by the sportsmen seated on elephants. The sport is exciting, but dangerous; for a wounded tiger has been known to spring on an elephant and to inflict serious wounds on the driver and occupants of the howdah, before it could be dispatched. A safer and more common method is to tether a live goat, or otherwise set a bait in a place where a tiger may be expected, then erect a platform on poles or in a tree near by, and await the animal's approach on a night when moon or stars shed light enough to enable the watcher to shoot his prey.

These great cats have always been kept in captivity by Oriental rulers, and now and then have been completely tamed. They have been a feature of every menagerie and animal trainer's show since such collections began to be formed, and as they readily breed in captivity the supply will easily be maintained. Consult Baker, 'Wild Beasts and their Ways' (London 1890); Blanford, 'Mammals of India' (ib. 1888); Lydekker, R. 'The Game Animals of India' (ib. 1907); Porter, 'Wild Beasts' (New York 1894), and books on sport and travel in India and the East Indies.

TIGER-BEETLE, a beetle of the family *Cicindelidæ,* in which the head is wider than the thorax, and the terminal hook of the maxillary jaws is jointed at its base. This insect is swift and active, and preys upon other insects. It is very often found in sandy places and the larvæ live in straight deep burrows in the ground. The color varies, corresponding as a rule to the general coloring of the surroundings. This beetle is more common in the tropics. Over 1,500 species are known, less than 100 of which have been found in the United States. Some species are wingless. See plate accompanying the article INSECTS.

TIGER-CAT, a name of not very definite signification, sometimes given to those animals of the family *Felidæ* which are of medium size, and somewhat resemble the tiger in form or markings, such as the chati, margay, serval, etc. In America the ocelot (q.v.) is most often meant. The marbled tiger-cat is a small beautifully variegated species (*Felis marmorata*) of the eastern Himalayan region.

TIGER-EYE, a semi-precious, chatoyant stone, of blue, yellow or brown color, which exhibits a charming change of colors when revolved. It is a silicious pseudomorph after crocidolite. The original mineral is changed by infiltration of silica and when accompanied by the oxidation of its iron its blue color is altered to yellow or brown. It is extensively cut into watch charms, cuff buttons and many fancy articles which are largely sold at many tourist resorts, often, though fraudulently, as of local origin, the mineral being found only in Griqualand, South Africa. See CROCIDOLITE.

TIGER-FLOWER, a Mexican plant (*Tigridia pavonia*) of the iris family, frequently cultivated for the brilliance and oddity of its flowers. These are solitary, terminal and cup-shaped in the centre, but have a wide-spreading limb, formed by the three obovate clawed segments of the perianth, which are the largest, and are brilliant red at the outer edge, shading to yellow, spotted with reds and purples at the base. The three inner segments are fiddle-shaped. The flowers are fugacious, lasting only a day, but there is a long succession of them. There are many varieties of these Tigridias, in which the hues of the corollas range through various shades of yellow to white. The stem is about a foot high, slightly zigzag and branched; and it bears a few alternate distant leaves, the greater number of the leaves being radical and sword-shaped. The tunicated corms need to be lifted into a dry place out of reach of frost during the winter, as they are not hardy in the northern United States. Tigridias are propagated by seeds or offsets. There are other species of the genus, which are not so handsome or conspicuous as *T. pavonia;* some of them have bluish flowers.

TIGER LAKE. See NAHUEL-HUAPI.

TIGER-LILY. See LILY.

TIGER-MOTH, one of the large moths of the genus *Arctia,* the caterpillars of which are known as «woolly bears» because of their heavy covering of black and brown hairs.

TIGER SHARKS, a shark (*Stegostoma tigrinum*) common in the Indian Ocean. The full-grown fish, from 10 to 15 feet long, frequent the open sea. The color is a yellowish-brown, with black or dark brown transverse bands or spots.

TIGER-SNAKE, a large blackish, yellow marked elapine poisonous serpent (*Notechis sculatus*), widely disseminated in Australia and Tasmania, and very numerous.

TIGHE, tī, **Mary** (BLACHFORD), Irish poet: b. Dublin, 9 Oct. 1772; d. Woodstock, County Kilkenny, 24 March 1810. She was married to her cousin, Henry Tighe, in 1793. Though her poem, 'Psyche, or the Legend of Love,' was privately printed (1805), it was only after her death that her complete writings were published. The first edition was in 1811, and they have been several times reprinted. The 'Psyche' is written in the Spenserian stanza and is founded on the story of Cupid and Psyche as narrated in 'The Golden Ass' of Apuleius. Her other poems are chiefly of a religious cast. It is probably as the subject of Moore's lyric, «I saw thy form in youthful pride,» and of Mrs. Hemans' 'Grave of a Poetess,' that Mrs. Tighe will be longest remembered.

TIGRANES (tĭg-rā'nēz) **I,** king of Armenia, 96 to 55 B.C. A descendant of Artaxias, the founder of the Armenian kingdom, he brought under his rule large accessions of territory in Syria and Mesopotamia, and in 83 B.C. had acquired most of the provinces of Syria from the Euphrates to the sea. By his marriage with the daughter of Mithridates, king of Pontus, he formed an alliance with that monarch disastrous to the smaller kingdoms of Asia Minor. He invaded Cappadocia in 78 and completely subjugated its inhabitants. Other wars followed and Tigranes became the mightiest king in Asia. He built the new capital, Tigranocerta, whither he transplanted the inhabitants of many captive places, including Cappadocia, Syria and Cilicia. His possessions were wrested from him by the Roman general Lucullus, but were nearly all recovered by Tigranes, only to be lost again to Pompey in 66. In the final defeat of Tigranes, Pompey was aided by the rebel son of the Armenian king, who claimed the provinces of Gordyene and Sophene for himself. Tigranes was able to retain only Armenia proper, for which he was obliged to pay Pompey an enormous sum and to subsidize the entire Roman troops under him. Tigranes was succeeded by his second son, Artavastes. Consult Reinach, T., 'Mithridate Eupator roi de Pont' (Paris 1890).

TIGRIS, tī'grĭs, Asia, an important river which rises near the Euphrates (q.v.) from two sources. The western and chief branch rises near Kharput, and under the name of Dejleh or Shatt, flows southeast. After passing Diarbekir it receives the eastern branch, flows past Mosul and Bagdad and joins the Euphrates at Kurna; together they form the Shattel-Arab and thus enter the Persian Gulf. The stream waters the ancient Nineveh, and separates Assyria from Mesopotamia on its way to Bagdad. It is only navigable for small boats and its entire length is 1,150 miles. Keleks, or large rafts, supported by inflated skins, are much in use for the transportation of freight. The chief tributaries are the Greater and Lesser Zab and the Diyala. The biblical name of the river is Hiddekel.

TILDEN, Douglas, American sculptor: b. Chico, Butte County, Cal., 1 May 1860. He lost his hearing in early life and was graduated from the State Institution for the Deaf in Berkeley, Cal. (1879). Taking up the study of sculpture in 1887 at the National Academy of Design, New York, and later abroad, he was appointed a member of the jury on sculpture at the World's Columbian Exposition in Chicago. He was elected a member of the National Sculpture Society, the New York Art Club, the San Francisco Art Association, etc., and was professor of sculpture at the Mark Hopkins Art Institute (1894–1900). His works include 'Base-Ball Player'; 'Tired Boxer'; 'Indian Bear Hunt'; 'Football Players,' etc.

TILDEN, Samuel Jones, American lawyer and statesman: b. New Lebanon, N. Y., 9 Feb. 1814; d. Greystone on the Hudson, near Yonkers, N. Y., 4 Aug. 1886. He was educated at Yale and at New York University, being graduated from the latter in 1837. He then studied law and was admitted to the bar in 1841. He attained the first rank in his profession, being particularly successful in reorganizing corporations involved in litigation, and amassing one of the largest fortunes ever gained in the practice of law. While a student in college, he had taken an active part in politics, writing and speaking in favor of Martin Van Buren's policy; in 1845 was elected to the New York State legislature and was a member of a special committee to consider the settlement of anti-rent troubles, his report on the subject forming the basis of subsequent legislation. In 1846 he was a member of the State constitutional convention and in 1848 was one of the delegates of the Free Soil faction of the Democratic party to the National Convention, but his political activity then slackened until after the Civil War. During the war, however, he was several times consulted by President Lincoln; he believed that the war, once begun, must be carried through by the Federal government, but opposed some acts of the administration as unconstitutional. In 1866 he was made chairman of the Democratic State committee and in 1867 was a member of the State constitutional convention. As chairman of the State committee he took a leading part in the overthrow of the Tweed Ring, opposing their delegates in the State conventions and being active in collecting evidence against their leaders and bringing them to prosecution; in 1872, having been elected to the State legislature, he was the leader in the impeachment of two of the Tweed judges. (See TAMMANY SOCIETY; TWEED, W. M.). In 1873 he resigned as chairman of the State committee; but in 1874 was nominated and elected Governor of New York. His administration was notable for his successful exposure of the «canal ring,» an association made up of persons who obtained contracts for canal work which they never fulfilled, but for which they were paid, and their political supporters. Governor Tilden employed a skilled engineer to examine their work and then surprised the legislature by a wholly unexpected special message setting forth in detail the fraudulent methods of the «ring.» This served as a direct appeal to the people; and so aroused public opinion that the legislature was forced to authorize the governor to appoint a canal commission. The reports of this commission resulted in a marked diminution in the appropriation for canals and the indictment of several officials for defrauding the State. In 1876 Tilden was the Democratic nominee for President of the United States, and received the largest popular vote, but lacked one electoral vote necessary for his election. As the electoral votes from several States were contested on account of alleged fraud, the matter was referred to a special Electoral Commission, which decided in favor of the Republican candidate, Rutherford B. Hayes. (See ELECTORAL COMMISSION). Popular excitement had run high and many Democrats still claimed Tilden's election, but he urged his supporters quietly to accept the decision of the commission. In 1880 and 1884 his party again wished to nominate him for the Presidency, but each time he declined the nomination. He bequeathed the most of his fortune to establish a public library in New York; but the will was contested by the heirs and only a part of the bequest came into the city's possession. (See TILDEN FOUNDATION). Consult 'Writings and Speeches of Samuel J. Tilden' (ed. by John Bigelow, 2 vols., New York 1885); 'Letters and Literary Memorials of Samuel J. Tilden' (ed. by John Bigelow, 2 vols., ib. 1908); Bigelow, J., 'Life of Samuel J. Tilden' (2 vols., ib. 1895); Haworth, 'Disputed Presidential Election of 1876' (Cleveland 1906).

TILDEN, (SIR) William Augustus, English scientist: b. London, 15 Aug. 1842. He was a graduate of various schools and of the Royal College of Chemistry; in 1864 became demonstrator of the Pharmaceutical Society; from 1872–80 science master at Clifton College; professor of chemistry, Mason College, Birmingham, 1880–94; president of the Institute of Chemistry, 1891–94; treasurer of the Chemical Society, 1899–1903 and president, 1903–05; professor of chemistry, Royal College of Science, London, 1894–1909, and dean of the college 1905; emeritus professor in the Imperial College of Science and Technology from 1909. In 1908 he was awarded the Humphrey Davy medal of the Royal Society. He published numerous scientific papers and in book form 'Introduction to Chemical Philosophy' (1876); 'Practical Chemistry' (1880); 'Hints on Teaching Chemistry' (1895); 'A Manual of Chemistry' (1896); 'A Short History of the Progress of Scientific Chemistry' (1899); 'The Elements' (1910); 'Chemical Discovery and Invention in the Twentieth Century' (1917) and 'Sir William Ramsay' (1918).

TILDEN FOUNDATION, The, one of the integral components of the New York Public Library Fund. By the will of Samuel J. Tilden (q.v.) the bulk of his property was left for the establishment of the Tilden Trust, to found a free public library and reading room in New York. This will was contested in a long suit in the courts and was broken in 1891, the property being decreed to the heirs. Mrs. William B. Hazard, one of the latter, was entitled by this decision to half of the estate, but she relinquished about $2,000,000 of her portion in order that Tilden's wishes might be carried out to some extent. In 1895 an agreement was reached whereby the trustees of the Tilden Trust Fund, the Astor Library and the Lenox Library agreed to unite their properties, forming a single «New York Public Library — Astor, Lenox and Tilden Foundations.» The city of New York subsequently agreed to erect on the site of the old reservoir, in Bryant Park, 40th to 42d streets on Fifth avenue, a handsome and spacious structure for these great libraries. The work was begun in June 1899 and completed in May 1911. See also LIBRARIES.

TILEFISH, a large oceanic fish (*Lopholatilus chameleonticeps*), allied to the cods, and belonging to the family *Malacanthidæ*, represented by the blanquilla and other well-known food-fishes of the Pacific Coast. It weighs from 10 to 40 pounds and is big-headed and brilliantly colored, with a curious triangular fatty protuberance on the top of the head in advance of the long low dorsal fin. Its flesh is excellent and it is caught in the same manner as are cod. The curious story of this fish is thus sketched by Lucas: «This fish, belonging to a tropical family having its headquarters in the Gulf of Mexico, was discovered in 1879 in moderately deep water to the southward of Massachusetts and on the edge of the Gulf Stream, where it was taken in considerable numbers. In the spring of 1882 vessels arriving at New York reported having passed through great numbers of dead and dying fishes, the water being thickly dotted with them for miles. From samples brought in, it was found that the majority of these were tilefish, while from the reports of various vessels it was shown that the area covered by dead fish amounted to somewhere between 5,000 and 7,500 square miles, and the total number of dead was estimated at not far from a billion. This enormous and widespread destruction is believed to have been caused by an unwonted duration of northerly and easterly winds, which drove the cold arctic current inshore and southward, chilling the warm belt in which the tilefish resided and killing all in that locality. It was thought possible that the entire race might have been destroyed, but, while none were taken for many years, in 1899 and 1900 a number were caught, showing that the species was beginning to reoccupy the waters from which it had been driven years before.» Consult Lucas, 'Animals of the Past' (New York 1902) and 'Reports' and 'Bulletins' of the United States Fish Commission, especially for 1884 and 1899.

TILES are stone, metal or composition slabs for use in covering a roof to keep out the water. Since the most common material is baked clay, and this same clay is used to form drain pipe, the word tile has been extended in meaning to cover clay pipes termed drain-tile. This same baked clay is often colored and fused on one side, giving it a glazed finish often of great beauty. Such colored and glazed tiles are used for interior walls, dados, floors, mantles, etc. Drainage tiles are made of native clay and usually glazed inside. Each tile has at one end an extended rim which overlaps the small end of the tile next to it, thus forming a continuous pipe. Roofing tiles take the form either of flat shingle or slate-like slabs or of pantiles. A section through a pantile shows a horizontal-like curve, one side of the tile being concave and the other convex — the latter curve fitting over the concave curve of the next tile, and so on. In this manner there is no opening left open to the weather. The same principle is often applied to the flat tiles and to ridge tiles, which bear on one edge a semi-circular convex lip, and on the other a concave one. Ridge tiles are made in angles to fit and cap the ridge-pole of a roof, to turn corners and to ornament projections. Roof tiles are glazed or dull, according to the maker's fancy, and are used in varieties of colors. Modern taste seems to prefer either highly glazed saffron or terra-cotta pantiles, or else dark dull flat ones. But during the Renaissance and until recent years highly colored glazed roof tiles either in the flat or corrugated style were in large demand throughout southern and central Europe. Fine examples of decorative roofs are preserved from the Middle Ages, a notable instance being the roof ot Saint Stephen's Cathedral in Vienna. Such tiles are often enameled and are thus rendered waterproof. Slate, marble and metal roof-tiles are occasionally employed.

Interior tiles are made in great varieties of shapes and sizes, colors and materials, ranging from fine brick-clay tiles to those of enameled and painted porcelain. They are used for pavements, flooring and revetments to walls. Old houses in the south of Europe were commonly paved with red brick-tiles baked hard and sometimes glazed. The method of decoration usually employed was to inlay clays of different colors in the bodies of the tiles, producing designs often of great beauty. Enameled tiles were used in the 15th and 16th centuries for the pavings of interiors of importance, such as chapels, chambers of honor, etc. These thin, enameled tiles broke easily and only a few examples are to-day preserved in the cathedrals and castles of France and Italy. The use of tiles for wall revetments and for dados was not general during these periods but has grown in recent years. Modern wall tiles are usually painted or glazed and are of various fine clays, not infrequently of porcelain. Large wall spaces are covered with painted tiles in pictorial or decorative composition, the work of Théodore Deck affording some fine examples. Tiles with slightly raised figures are also used, the style having been borrowed from the Persians who are masters of their manufacture. A recent effective use of colored clay tiles may be seen in the subway stations in New York, where especially pleasing effects have been inexpensively produced by the judicious selection and blending of colors. Modern usage does not follow the example of the Middle Ages in the employment of carved and leaded marble tiles. In these latter the variously shaped slabs of stone were incised with intricate and elaborate designs and the incisions filled with lead or colored compositions and sometimes with fine mosaic work. Consult Church, W. A., 'Patterns of Inlaid Tiles,' etc. (1845); Herdtle, H., 'Vorlagen für das polychrome Dachornament' (1885); Jones, Owen, 'Designs in Mosaic and Tessellated Pavements,' etc. (1842); Monceaux, Henri, 'Les carrelages historiés du moyen-âge et de la renaissance,' etc. (1887); Wallis, Henry, 'Italian Ceramic Art,' etc. (1902) and the papers of Ricardo, H. R., on 'Architect's Use of Enameled Tiles' (in *The Architectural Review* for 1902, Vol. XI).

TILGHMAN, tĭl'man, **Mathew**, American patriot: b. Queen Anne County, Md., 17 Feb. 1718; d. Talbot County, Md., 4 May 1790. He was a member of the Maryland assembly in 1751 and as a magistrate and prominent member of Talbot County was a member of the committee which drew up the Maryland protest to the Stamp Act. In 1774 he was made president of the Provincial Congress or Convention which controlled the affairs of the colony until its statehood, and in 1777 represented Talbot County in the Provincial Senate. He was a delegate to the Continental Congress, 1775–77 and was throughout the entire pre-Revolutionary period a staunch defender of the cause of independence and an able advocate of civil rights.

TILGHMAN, Tench, American soldier, nephew of M. Tilghman (q.v.): b. Talbot County, Md., 25 Dec. 1744; d. Baltimore, Md., 18 April 1786. His career as a merchant in Philadelphia was interrupted by the Revolution. He joined the Continental army at the outbreak of the war and was one of the officers sent to confer with the Six Nations. In

1776 he was appointed aide-de-camp to Washington, in which position he continued to the close of the war and in this capacity was entrusted with the bearing of the surrender of Cornwallis to Congress on 19 Oct. 1781. In May 1781 he was made lieutenant-colonel to take rank from 1 April 1777. At the close of the war he settled in Baltimore, where he again took up a mercantile life. Consult ‹Memoir of Tench Tilghman› (Albany 1876).

TILIACEÆ, a family of trees, the lindens, with some shrubs and a few herbs, mostly indigenous to the tropics, especially in South America and Asia. A few are natives of the north temperate zone. The chief genus is *Tilia*, characterized by alternate, simple leaves; solitary or variously grouped axillary flowers with four or five sepals and petals, numerous stamens with two-celled anthers; and several-celled capsules or drupes. One of the most striking peculiarities of the family is the abundance of mucilaginous substances in various parts of the plants, particularly in the young twigs, inner bark and buds. On this account several species are valued for stock-food. Many of the species are noted for their tough fibrous bast, often used for making cordage, bagging and even fine fabrics, as in the case of jute. Some species furnish edible fruits, for instance, *Grewia denticulata*, which yields large quantities of acid drupes about half an inch in diameter. The linden and the basswood are particularly useful trees in the cool temperate zone, where they are employed for timber, street and park planting and as forage for bees, their abundant nectar furnishing one of the finest grades of honey. See LINDEN; CORCHORUS; FIBRE; JUTE; LIME.

TILL, a heterogeneous mixture of clay, boulders, sand, gravel and rock flour, covering generally the surface of the rocks in the glaciated region. It represents the ground moraine of the great Pleistocene ice sheet, which finally slid over it and compacted it more or less firmly. It sometimes rises locally in compressed dome-shaped eminences known as drumlins. Till or boulder clay is unstratified, in contrast to glacio-fluvial deposits, or modified drift. Till that has become consolidated is known as tillite. See GLACIAL PERIOD; DRIFT.

TILL EULENSPIEGEL. In ‹Till Eulenspiegel› Friedrich Lienhard exemplifies his favorite method of treating, with manifest application to his own time, an old genuinely German subject conceived in a way that is no less novel than poetic. The work is in three parts. The first, ‹Eulenspiegels Ausfahrt› («Eulenspiegel's Departure»), and the third, ‹Eulenspiegels Heimkehr› («Eulenspiegel's Return Home»), were brought out together in 1896; the second, ‹Der Fremde› («The Stranger,» 1900), is an episode capable — as is also the first part — of separate representation.

The traditional coarse and rascally practical joker of the 15th century (see EULENSPIEGEL) is transformed in Lienhard's drama into an idealist. He is no hero; he lacks the poise of a humorist, he has too much sentiment to be a cynic; knowing the worth of life, he rebels against pettiness and narrowness, but he has no other weapon than somewhat hollow laughter, and no other plan of campaign than somewhat boorish mischief-making. The transformation is not unlike that of the 16th century Faust at the hands of Goethe; but the scope of Lienhard's subject is naturally narrow in comparison with Goethe's and the setting of his action is more specifically historical. There is a melancholy suggestiveness in the fact that Lienhard's Till meets his end in the Peasants' Revolt, and in the further fact that Lienhard dignifies him with the approval of Hans Sachs — giving, as it were, to the individualist who, in a contemptible time, could find no better place than that of court fool, the sanction of the Nuremberg shoemaker's optimistic faith in social regeneration.

That Hans Sachs should be brought into this action at all is enough to indicate that Lienhard was less concerned for the probability of his plot than for its atmosphere. If it is probable that in Eulenspiegel's community there should be so sane and resolute a peasant girl as Gertrude, to whom he is sincerely devoted, it is improbable that his love for her should not have sufficed to steady him. As the «stranger» of the episode he finds — meanwhile oblivious of Gertrude — a kindred spirit in the daughter of an innkeeper. But when a wager has carried him from an artful pretense to the point of realizing this spiritual kinship, he seems to see no incongruity in abandoning the girl to the commonplace lover whom she has promised to marry, in case she loses the bet. However, neither the plot nor the farcical comedy, of which there is no lack, gives this work its chief significance. The modernized Eulenspiegel is a Diogenes. It is hardly his fault if, in his search for an honest man, he does not even find himself.

WILLIAM G. HOWARD.

TILLAGE. See AGRICULTURE IN THE UNITED STATES.

TILLETT, Benjamin, English labor leader: b. Bristol, 1859. He was employed in coal pits and brickyards from the age of eight years, went to sea at 12 and served in the navy for two years after he was 17, being then invalided out of the service. He later became a tea cooper and in 1887 was one of the organizers of the Tea Cooper's and General Laborers Association. He was also associated with the organization of the Dock, Wharf and General Workers' Union of Great Britain and Ireland and became its secretary. He was one of the leaders of the Great Dock Strike of 1888; for many years an alderman of the London County Council, and was several times an unsuccessful candidate for Parliament. He was a loyal worker for maximum production during the European War and was one of the labor leaders sent to visit the Western battle front. Author of ‹Trades Unions and Socialism› (1894); ‹History of the London Transport Workers' Strike, 1911› (1912).

TILLETT, Wilbur Fisk, American Methodist theologian: b. Henderson, N. C., 25 Aug. 1854. He was graduated from Randolph-Macon College in 1877 and from Princeton Theological Seminary in 1880. He held a pastorate at Danville, Va., 1880–82 and has been professor of systematic theology at Vanderbilt University since 1884 and vice-chancellor there from 1886. He has published ‹Our Hymns and Their Authors› (1889); ‹Discussions in Theology›

(1890); 'Personal Salvation' (1902); 'The Doctrines of Methodism' (1903); 'A Statement of the Faith of Worldwide Methodism' (1906); 'Hymns and Hymn Writers of the Church' (with C. S. Nutter, 1911).

TILLEULENSPIEGEL, tĭl'oi"lĕn-spē-gĕl, a series of stories collected and first published in Low Dutch, in the year 1483. See EULENSPIEGEL; TILL EULENSPIEGEL.

TILLITE, a rock consisting of a heterogeneous or non-stratified mixture of boulders and sand, supposed to have been glacial till originally. The name was applied by Davis to beds in the South African Permian succession believed to have been of glacial origin. Shantum tillite is a member of Roxburg Conglomerate in eastern Massachusetts of Carboniferous, possibly Permian, age. See TILL.

TILLMAN, Benjamin Ryan, American legislator: b. Edgefield County, S. C., 11 Aug. 1847; d. Washington, D. C., 3 July 1918. He received his education at Bethany Academy, entered the Confederate army on the outbreak of the Civil War, but was obliged to forego active service owing to a severe illness. The close of the war found him undertaking the management of his mother's farm in the back country, a farmer in spirit and life. During the troubled days of Reconstruction he played his part in the reprisals of the whites. In the '80's a curious political situation developed in South Carolina, which finally landed Tillman in the governorship. The aftermath of war and the persistence of caste lines put a widening gulf between the aristocrats of the seaboard plain and the back country people of the mountains. With the overturning of the Republican domination the patrician class began to resume once more oligarchic rule of the State. There were mutterings of discontent among the mountaineers and farmers in the backwater districts. As champion of the latter Tillman suddenly found himself thrust forward. In 1890 in the most bitter campaign in the State's history he was elected governor. From the day of his inauguration to the end of his second term South Carolina was a constant ferment. The one incident of his rule that stands out among all the other turbulent affairs was his promulgation of the famous dispensary law and the events following it. This law gave sheriffs and constables the power to enter stores and private houses and to seize any liquors found there which did not bear the stamp of the State. Riots occurred; Tillman ordered out the militia; some companies refusing to obey this summons were publicly degraded, and conditions bordering on anarchy existed, but the law stayed and the governor was triumphant. Tillman soon became a national figure. He took a prominent part in the State Constitutional Convention of 1895, which set an educational qualification for the franchise, and by his violent attitude against the negro he became the object of attack by Northern sentimentalists. He was a bitter opponent of Cleveland; his speeches against the latter gaining him the name of «Pitchfork Ben.» In the national Democratic conventions of 1896, 1900 and 1904 Tillman was the stormy petrel who raged at all who opposed his views. In 1894 he was elected to the United States Senate and was re-elected in 1900, 1906 and 1912. His terms in the Senate were marked chiefly by the quarrels he had. Cleveland he had hated and it was not in the realm of possibility that he and Roosevelt could be other than enemies and enemies they frankly were during Roosevelt's incumbency of the Presidency. In his later years Tillman became less and less the bugaboo in the eyes of the people who had at first opposed him with all of the bitterness of caste and class. As he broadened into a national figure and in the Senate fought the fight of the whole South with untiring vigor, he came first to be tolerated, then respected by all the people of his State. The closing years of his life found him chairman of the Senate Committee on Naval Affairs, perhaps the second most important governing body in the country, and as such he worked incessantly for the building up of the navy. He advocated a greater navy, government armor-making plants, etc., and warned manufacturers that the government would force them to act fairly. He supported his friend, Secretary Daniels, maintaining in public and private that Daniels was a misunderstood, much underestimated man who would prove his worth in time.

TILLMAN, Samuel Escue, American soldier and author: b. near Shelbyville, Tenn., 2 Oct. 1847. He was graduated from West Point in 1869, and assigned to frontier duty. In the following year he was called to West Point as assistant professor of chemistry, and was later appointed professor of mineralogy and geology. He continued to teach in the Military Academy for many years, being retired by operation of law on 2 Oct. 1911. In 1874–75 he served as a member of the United States expedition to Tasmania to witness the transit of Venus. He was recalled to active duty on 6 June 1917 and assigned to duty as superintendent of the United States Military Academy. He is the author of 'Essential Principles of Chemistry' (1884); 'Elementary Mineralogy' (1894); 'Elementary Lessons in Heat' (1889); 'Descriptive General Chemistry' (1899); 'Important Minerals and Rocks' (1900), and other textbooks.

TILLODONTIA, a group of extinct mammals, chiefly of the North American Eocene rocks. They were large plantigrade, five-toed land animals, whose skeleton presents characters intermediate between those of *Carnivora* and *Rodentia*. The brain is small and slightly furrowed. The dentition was complete and marked by large, rodent-like incisors. A prominent genus was *Tillotherium*. See RODENTIA.

TILLOTSON, tĭl'ŏt-sŏn, **John,** English prelate, archbishop of Canterbury: b. Sowerby, Yorkshire, October 1630; d. 22 Nov. 1694. His father, a strict Calvinist, brought up his son in the same principles. He was graduated at Cambridge and elected a Fellow of Clare Hall in 1651. In 1666 appeared his 'Rule of Faith,' a reply to a work by John Sergeant, an English clergyman, who had become a convert to the Catholic faith. In 1670 he became prebendary of Canterbury. When Charles II, in 1672, issued a declaration for liberty of conscience for the purpose of favoring the Roman Catholics, he preached strongly against it, but was, nevertheless, advanced to the deanery of Canterbury, and three years after (1675) presented to a prebend in Saint Paul's. On the accomplishment of the revolution he was taken into favor by King William, and in 1689 he was appointed dean of Saint Paul's. On the suspension of Archbishop Sancroft as a non-juror he was appointed to exercise the archiepiscopal jurisdiction, and in 1691 accepted the archbishopric itself. He had previously formed an abortive scheme for the comprehension of the Presbyterians within the Church, and had also failed in another design for forming a new book of homilies. When, therefore, he accepted the primacy, a large party assailed him with great animosity. He bore these attacks in silence, and even prevented some prosecutions for libel against him, directed by the Crown. He was also charged with Socinianism; in answer to which he republished four of his sermons on the ‹Incarnation and Divinity of Our Saviour.› The only class to whom he did not show a mild and tolerant spirit was the Roman Catholics, toward whom he had a strong aversion. Tillotson's sermons were for half a century the most popular of that class of compositions in the English language but have since fallen into neglect and even disesteem. In other respects than that of style they are generally commended for benignity of spirit rather than depth or richness of thought. An edition of his sermons was published by his chaplain, Dr. Ralph Barker (14 vols., London 1695–1704). Consult also Birch, Thomas, ‹Life› (London 1752).

TILLY, tĭl'ĭ (Fr. tē-yē), **Johann Tserklaes**, COUNT OF, Bavarian commander: b. Castle Tilly, Brabant, near Belgium, February 1559; d. Ingolstadt, Bavaria, 30 April 1632. He received a strict Jesuit education, but preferring life in the army he became a soldier of fortune in the service of Spain, and later in that of Austria, after which he attached himself permanently to the Bavarian army, and under the banner of its king, the head of the Catholic League, entered upon the Thirty Years' War. His first signal victory was that of White Mountain, 6 Nov. 1620, when he defeated the Protestants in Bohemia. He was victorious over Christian of Brunswick at Höchst (1622) and Stadtlohn (1623), thus gaining the title of Count of the Empire. In 1626 he compelled Christian of Denmark, who had joined the Protestant forces in Saxony, to retire into his own domain. In 1630 he was made commander of the Imperial army and in 1631 won the famous battle of Magdeburg against Gustavus Augustus of Sweden and the Saxon Protestants. In the following September the Bavarian troops were, however, completely routed by the Swedes at Breitenfeld, and in the engagement upon the river Lech, April 1652, Tilly, who had been victorious in 36 battles in the religious wars of Germany, was mortally wounded. Consult Klopp, O., ‹Tilly in Dreissigjährigen Krieg› (Stuttgart 1861); Villermont, ‹Tilly, ou La Guerre de trente ans› (Tournay 1859); Wittich, K., ‹Magdeburg, Gustav Adolf und Tilly› (Berlin 1874).

TILSIT, Germany, a town in East Prussia, at the confluence of the Memel or Niemen, and the Tilse, 65 miles northeast of Königsberg. Its principal buildings are the gymnasium, realschool, churches, theatre, barracks, castle ruins and benevolent institutions. The chief manufactures are iron castings, machinery, paper, soap, glass, oils, snuff, chemicals, cloth, cheese and leather. The eel and salmon fisheries are important, as well as the large stock-markets. At Tilsit the famous peace ending the Russian-French-Prussian War was concluded (1807), by various concessions, changes of territorial government, Napoleon largely dictating the terms. In the early days of the European War in 1914 Tilsit was taken by the Russians, but later abandoned. See WAR, EUROPEAN. Pop. 40,000.

TILTON, Theodore, American journalist: b. New York, 2 Oct. 1835; d. Paris, France, 25 May 1907. He was graduated from the College of the City of New York in 1855 and became a journalist on the New York *Observer*. In 1856 he joined the editorial staff of the *Independent*, and in 1863 became its editor-in-chief. In 1871 he became an editor of the Brooklyn *Union*, but shortly after established a weekly periodical, the *Golden Age*, which he discontinued in 1874. In 1874 he caused great consternation in Plymouth Church, Brooklyn, and a sensation throughout the country, by accusing the Rev. Henry Ward Beecher of criminal intimacy with his wife. The trial which resulted in the disagreement of the jury, covered a period of six months. After 1883 he lived abroad. He was the author of several volumes of verse, ‹The Sexton's Tale and Other Poems› (1867); Thou and I› (1880); ‹Swabian Stories› (1882); ‹The Chameleon's Dish› (1883); ‹Heart's Ease› (1894); a novel, entitled ‹Tempest-Tossed› (1873); ‹The Fading of the Mayflower: A Poem› (1906).

TIMARU, a New Zealand town on South Island in Geraldine County, on the east coast, 100 miles by rail southwest of Churchtown. It is an important railroad centre, being situated at the very junction of the Fairlie line. The principal exports are flour, wool and frozen meats. Timaru has a fine harbor. Pop. about 6,424.

TIMBER AND STONE LAW. On 3 June 1878 Congress passed the Timber and Stone Law which with certain amendatory acts is now in force. Under this law all unreserved unappropriated, non-mineral surveyed public lands within the public land States which are chiefly valuable for the timber or stone thereon and unfit for cultivation at the date of sale, may be sold at their appraised value but in no case less than $2.50 per acre. One timber and stone entry may be made for not more than 160 acres (a) by any person who is a citizen of the United States or who has declared his intention to become such citizen, if he is not under 21 years of age and has not already exhausted his right by reason of a former application for an entry under this act or has not already acquired title to or is not claiming under the other public lands laws any other lands which with the land for which he applies would aggregate more than 320 acres or (b) by an association of such persons or (c) by a corporation each of whose stockholders is so qualified. Provision is made for a careful appraisement of the value of the timber and stone on the land in question and the applicant must make payment in accordance with such appraisal.

TIMBREL, a musical instrument much resembling a tambourine (q.v.), has been in use since the earliest times. It is mentioned in the first book of the Old Testament (Ex. xv, 20), and seems to have been known to all ancient peoples. It is also known as the tabor, tabret, tambor, etc., and its form varies from the bottle-shaped drum of Egypt or the long narrow drum of Provence, to the modern tambourine of Spain.

TIMBUKTU, tĭm-bŭk'too (also spelled Tombouction and Timbuctoo), French Sudan, a celebrated trading station situated on the great bend of the Niger River, on the southern border of the Sahara, in lat. 16° 43′ N., and long. 2° 57′ W. The city lies in a desert region about nine miles from the banks of the river, and 800 feet above sea-level. It measures three miles in circumference, and consists of adobe houses without windows. In the centre are three large mosques, and on the northern outskirts two forts. The commerce by caravans across the Sahara was formerly enormous, is still considerable and again increasing, being estimated at $4,000,000 annually. The trade is chiefly salt, fabrics, hardware, ostrich feathers rubber, cotton, tobacco, sugar and gold. Recent excavations have disclosed ancient Egyptian architecture pointing to a prehistoric foundation. The modern city was founded toward the end of the 11th century, and became known to Europeans in 1353. Owing to its former difficulty of access Timbuktu was long an object of curiosity for travelers. The sultan of Morocco captured the city and adjacent territory in 1590, deposing the native Songhoi rulers. After a time the Moroccan rule was thrown off, and various tribes controlled the city until the French took possession of it in 1893. A telegraph line connects with Algeria. A French military territory has its headquarters there. Pop. (1917) about 16,000, almost all Mohammedans. Consult Dubois, 'Timbuctoo, the Mysterious' (1896); Lady Lugard, 'A Tropical Dependency' (London 1905).

TIMBY, Theodore Ruggles, American inventor: b. Dover, Dutchess County, N. Y., 5 April 1822; d. Brooklyn, N. Y., 1909. He «was an inventor from childhood,» says Parton, and at 16 invented the floating dry dock. Among his other inventions are those of floating batteries of iron and steel for coast-defense; a method of sighting and firing heavy guns by electricity, patented in 1862 at Washington, afterward adopted by the United States government, and now used in all leading countries; the American turbine wheel; the first portable barometer; the process of printing terrestrial globes in colors; and a process for quickly ripening coffee. He was the first to advocate the modern use of iron in the construction of warships, and his most famous invention is the revolving turret which was first introduced in the original *Monitor* (see MONITOR, THE; MONITOR AND MERRIMAC), and has since been adopted in naval architecture throughout the world. This invention, through official neglect and other failure to recognize and proclaim Timby's contribution to the national defenses that gave victory in «the battle upon which hinged the fate of the Civil War,» has been wrongly ascribed to John Ericsson (q.v.), chief engineer of the *Monitor*. But the true history of the case shows that as early as 1841 Timby exhibited at the War Department a model and plans of a revolving battery, to be made of iron, the idea of which was suggested to him when first he observed the circular form of Castle William on Governor's Island, New York harbor. In 1843 he is said to have filed his preliminary specification of the model and plans in the United States Patent Office, and Caleb Cushing the same year sent a duplicate model to China. (See illustration under MONITOR). The published records of the office reveal patent No. 3,673 sealed to Theodore R. Timby of Cato, N. Y., in 1844 for an improved waterwheel, also patent 4,845, 10 Nov. 1846, for its further improvement, and this is recorded as expired in 1861. On 31 Dec. 1844 a patent was granted to John Ericsson for propelling ships. But there is no record of the revolving floating or coastal battery by either inventor. It is interesting to note, however, that 11 Aug. 1841 a patent was granted to Prosper Martin of Philadelphia, Pa., for floating batteries; and 11 Oct. 1841 to Daniel Fitzgerald, New York, for submarine gunboats. Timby, from 1851 to 1861, is said to have urged the importance of the revolving floating battery on Emperor Napoleon III. Meanwhile, having developed improvements in his invention, the outbreak of the Civil War was his opportunity, and on 8 July 1862 patents Nos. 35,846 and 35,847 were granted to Theodore R. Timby of Worcester, Mass., for (a) revolving battery tower, (b) discharging guns in revolving tower by electricity, and (c) No. 36,593, 30 Sept. 1862 improved revolving battery tower. Incidentally in 1862–63 he received patents for portable warming apparatus; for mercurial barometers; for solar time globe and solar timepieces. The only records of patents to John Ericsson around these dates are three in 1863 comprising (a) instruments for taking soundings; (b) port-stopper for vessels of war; (c) operating gun carriages. Under his revolving battery tower and related patents, Timby entered into an agreement with the builders of the *Monitor*, including Ericsson as supervising engineer, for its use in the construction of that vessel, and received therefor $5,000. He also received $5,000 royalty for each of the two subsequent vessels built by that company. Although this American inventor received no compensation and no official recognition of his services to the country, his claims were not officially disputed. His invention of the revolving turret, as well as of the «Timby system» of coast-defense adopted by many nations, has been acknowledged by military and naval authorities at home; the legislature of New York passed (1890) a concurrent resolution declaring it to be the «duty of Congress to make such investigation . . . as shall do ample justice in the premises and vindicate the genius that contributed so largely in rescuing the country from a grave peril during the darkest days of its existence»; and influences were brought to bear on Congress and elsewhere to secure full acknowledgment of his patent rights and remuneration for his work from the United States government. Bills to this end were introduced in the national Senate in 1893 by the senators from New York, but apparently without result. An interesting applicable commentary on such conditions may be found in the report of Charles M. Keller, examiner of patents for the year 1844 (Doc. No. 78, p. 507):

«It is a matter of surprise that society at large which has been and must continue to be so much benefited by inventions and the progress of the useful arts should pay so little attention to this subject. The fruits of the labors of inventors are enjoyed and recognized by the world at large, but the authors of all these benefits pass through the world unnoticed, and in most cases unrewarded. It is to be regretted that literary men do not turn their attention to the progress of the useful, and, with the pen of fancy, add ornament and beauty to the solid edifice. Mr. Timby received patents for a mole and tower system of defense (1880); a subterranean system of defense (1881); and a revolving tower and shield system (1884). In his later years he was a resident of Brooklyn, N. Y., where he occupied himself with various literary and other avocations, being especially interested in scientific and philosophical pursuits. Among his writings is a volume entitled ‹Lighted Lore for Gentle Folk› (1902), which contains his reflections on a variety of subjects. Consult New York *Herald* and New York Evening *Post*, 7 June 1843; *Harper's Monthly*, January 1863, pp. 241–248; ‹American Annual Cyclopædia,› 1864, «Revolving Turrents,» pp. 719–723; Todd, ‹Nuts for Boys to Crack› (1866), p. 166; Parton, ‹The People's Book of Biography — Lives of the Most Interesting Persons of All Ages and Countries,› containing a sketch of Timby and an account of his connection with the *Monitor;* King, «Theodore R. Timby» (in *Successful Americans*, January 1902); *American Shipbuilder*, 23 Oct. 1902, «A Half-forgotten Hero»; and Memorial of the Patriotic League of the Revolution to the 57th Congress, presented by Virginia Chandler Titcomb, 1902.

JOHN H. CLIFFORD,
C. LEONARD-STUART,
Editorial Staff of The Americana.

TIME, that dimension of the world which we express in terms of before and after. Our experience of time is in general analogous with our experiences of space (q.v.), but it has certain important differences from the latter. These reside primarily in the fact that whereas it is customary for us to think only of the physical order of things in spatial terms, the temporal sequence pervades mind and matter alike. For this reason many philosophers who have treated of space as something secondary and derived have assigned to time a very fundamental status. This has been especially the case among such idealists as Berkeley. In Leibnitz's philosophy time appears as the backgound, so to speak, of the pre-established harmony between the monads, while space is merely the confused perception of their logical relations. Royce, like most of the Absolutist disciples of Hegel, holds a view of time which makes it prior to all finite minds, forming their natural environment, as it were, while for the Absolute Experience it is merely a phase of mental content. Bergson considers time the only true dimension of Being, when this is perceived in the truest manner by intuition, while he considers space as an artificial intellectualization of the time process.

These views of the nature of time are opposed to those which assimilate it to space. Kant, for example, makes time the form of the internal sense and space the form of the external sense. The time of the natural scientist has always partaken of the nature of space and now partakes of this nature more than ever, for it is considered by the advocates of the theory of relativity (q.v.) that a moving body carries with it a temporal system entirely different from that of the world with reference to which it is at rest and that the true units of both time and space are neither points nor moments, but moments-in-the-history-of-a-point. The grand problem in the philosophy of time consists in the harmonization of these physical time theories with the apparent differences between time and space.

The first step toward the closing of this breach is the analysis of our experience of time. This has been done with great care by William James (q.v.) in his ‹Principles of Psychology.› He finds that within a definite, limited interval of duration, known as the specious present, there is a direct perception of the temporal relations. After an event has passed beyond the specious present, it can only enter into consciousness by reproductive memory. As James says, «The object of memory is only an object imagined in the past to which the emotion of belief adheres.» One might add in the same way that our cognition of the future is only cognition by anticipation and that the object of anticipation is only an object imagined in the future to which the emotion of belief adheres.

We thus see from James' account that our temporal experience is divided into three qualitatively distinct intervals: the remembered past, the perceived specious present and the anticipated future. By means of this tripartite division, we are able to orient our present selves in the temporal stream of our own experience. However, we do not merely have at our disposal the temporal order generated by our present experience, but the memory of the temporal orders of past experiences, and the expectation of the temporal orders of future experiences. These temporal orders are themselves subject to a correlation and a temporal arrangement, for two temporal orders not too remote from one another will possess in common certain items by which they may be compared and the order of their specious presents be determined. As a consequence, it is possible to construct a secondary temporal order of the immediately given temporal orders of our experience and it results directly from this that we can construct a temporal arrangement of our specious presents and their contents. We thus see how it is possible for time to have its roots in experience and yet to be a dimension in which experiences and their contents are arranged.

Now, it has been shown in the article on space that the ease with which space undergoes scientific manipulation is due to the fact that the space of science is a construction from the spatial data of our experience which is largely determined by considerations of scientific convenience. As we have just seen, the fact that experiences are arranged in time does not prevent the stuff from which time is made from being of the nature of experience-data. There is consequently no obstacle to a treatment of this material in a manner entirely parallel to the physical treatment of space, or to the combination of time-data with space-data and other empirical data into a single universe which is not separable into purely spatial and purely temporal dimensions, as in the case of the theory of relativity. Of course, the time of science, like the space of science, is a construction which is largely arbitrary and so in a sense a fiction, but there is reason to believe that the time of the unscientific man, of Bergson himself, owes its homogeneity, its unique, definite direction of flow, its continuity, to more or less unconscious acts of construction which differ in degree, not in nature, from those of the scientist. There is no reason to believe that our time data, taken raw, unordered, unschematized, indicate of themselves a single series into which all events fit in a definite order; indeed, there is good reason to believe that the laws which we unquestioningly associate with time are outlined only in the vaguest way in our definite temporal experiences.

Before leaving the subject of the philosophy of time, a word or two must be said concerning the Zenonian paradoxes. These have to do with the flying arrow, which cannot remain where it is, nor be where it is not, and with Archiles, who, though the swiftest of men, cannot catch up with the slow tortoise except by occupying an infinity of positions, and with other similar matters. In fact, though these paradoxes seem to deal with space and time, they deal with the properties of infinite assemblages (see ASSEMBLAGES, GENERAL THEORY OF) and dense series and were in truth unanswerable until the recent thoroughgoing mathematical treatment of these matters, though they have now been completely solved. (For a more detailed treatment of these paradoxes see ZENO OF ELEA). Here it is only necessary to state that Bergson mistakenly regards these difficulties as insurmountable on an intellectualistic view of time and that James turns them to use in proving his theory that time is discontinuous.

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TIME, Measurement of. All our measures of time depend primarily upon the motion of the earth upon its axis and around the sun. The first motion enables us to count off the successive days; the other the successive years. The measurement of time thus becomes a most important branch of practical astronomy in the affairs of men. It falls into two distinct classes, the determination of the years and that of the days or fractions of a day. Other units of time than this may be regarded as subsidiary. Centuries are determined by the count of years; weeks and months by a count of days; hours, minutes and seconds by dividing the day into fractions.

The primary object of a measure of time is the expression or determination of the moment or date of any event. This is expressed by the period of time elapsed since some standard moment or epoch. Long intervals, expressed in years, are measured from some great epoch, chosen by a nation — in all Christian nations the birth of Christ is taken for this purpose. The general subject of measuring or expressing long intervals of time is treated in our article Chronology (q.v.). The present article deals mainly with fractions of a day, or with what is commonly called the "time of day."

To express the time of day we must have a moment at which we consider the day to begin and from which we count the hours and minutes. The natural moment for this purpose is that when the sun crosses the meridian, because it can be more easily observed than any other phenomenon growing out of the earth's rotation. This moment is actually taken as the beginning of the day by astronomers on shore and, to a large extent, by navigators at sea. The latter usage grew out of the fact that at noon the navigator determines the latitude of his ship. But, to express the moment of an event, navigators are now beginning to count from midnight, as landsmen habitually do. The Jews formerly considered the day to begin at sunset and the practice in ancient times was to divide the 24 hours into two parts, the day and the night. Each of these parts was divided into 12 hours. Thus men had the first, second and third hour of the night, etc., and the corresponding hours of the day, as we see in the Bible. Owing to the inequality in the length of the day at different seasons of the year, the hours thus employed were of unequal length. In an age when the modern clock was unknown and there was no accurate instrument for measuring time in universal use, this inequality was of little importance. But when an accurate measure was once obtained, a more uniform measure of the hours became necessary. For obvious reasons midnight became the most convenient time to begin the day of 24 hours. Thus arose the system of setting the clocks at 12 when the sun crosses the meridian, beginning a new day 12 hours later when the clock marks midnight and dividing the hours into A.M. and P.M. This system was adopted without change until the introduction of railways showed its defects and made a slight modification necessary.

The first inconvenience felt from the system arose from the fact that the intervals between successive noons, as indicated by the passage of the sun across the meridian, are not equal. To show the nature and effect of the inequality, let us suppose a perfect clock so regulated as to go always at the same rate and to be set at noon on 1 January of any year at the moment when the sun crosses the meridian and to be so exactly regulated as to again show noon on 1 January of the year following. It will be found that, during the month of January, the clock will continually gain on the sun at a rate of 28 seconds a day at the beginning of the month, which rate will continually diminish to eight seconds at the end of the month and will change to a losing rate about the middle of February. The effect of the accumulation will be that, at the latter date, the clock will be found to be more than 10 minutes ahead of noon when the sun crosses the meridian. Then it will begin to fall back for several months until, in May, it will be seven minutes slower than the sun. Then it will forge ahead again and again fall behind until, when January again comes around, it will once more coincide with the sun.

This inequality between the moments of the sun's successive transits over the meridian is due to two causes; the obliquity of the ecliptic and the eccentricity of the earth's orbit. If, instead of using the sun, we measured time by the apparent diurnal motion of the stars, no inequality would be noticeable. The effect of the eccentricity is that the sun seems to move forward among the stars more rapidly in the winter months than in those of summer. And the effect of the obliquity of the ecliptic is a still larger inequality, going through its cycle of changes twice in a year.

So long as an error of modern fractions of an hour was of no importance, people in general had no occasion to trouble themselves with this inequality; but when time had to be measured to a minute, it became intolerable, and the system of mean time had to be introduced. The latter is defined by the going of a perfect clock in the manner already supposed, and so set that, in the average of the whole year, it shall be as much ahead of the sun as behind it. The greatest difference between the clock and the sun will then be about 16 minutes, which difference occurs in one direction early in November, and in the other about the middle of February. The difference is called the *equation of time* and is given for each day in the household almanac, thus enabling the household clock to be set by the sun. Some such system as this is now used in all civilized countries where exact time is of importance.

Besides true solar time and mean solar time, a species of time of great importance to the astronomer is sidereal time. Sidereal time is measured by the stars, or rather by the daily motion of that point in the equator from which the true right ascension of the stars is reckoned, called the vernal equinox. Two successive upper transits of the vernal equinox over the same meridian determine a sidereal day, which is nearly 3 minutes and 36 seconds shorter than a mean solar day, but divided, like it, into 24 hours. About 21 March are sidereal and mean times agree; the former gains on the latter an entire day in the year. The sidereal day commences at the instant the vernal equinox makes its upper transit, and, therefore, changes in 12 months through the entire 24 hours. The hours are counted from 0 to 24.

Time may be determined by observations on the sun or stars with a sextant, or an altazimuth for rough purposes, or with a transit adjusted to the meridian, for refined work. With the last instrument a chronograph is frequently used for recording the observations. The telescope usually has from 5 to 11 equidistant lines ruled on glass (or spider lines), which are placed in the common focus of the eye-piece and object glass, the centre line being adjusted to the optical axis of the telescope and set in the meridian. When ready for observations, the observer sets the telescope at the proper angle to observe the passage of the star across the meridian,and records on the chronograph the transit over each line by interrupting the circuit with an observing key held in the hand and electrically connected with the chronograph, on which a break-circuit chronometer is making a continuous record. The chronograph sheet is read by means of a scale.

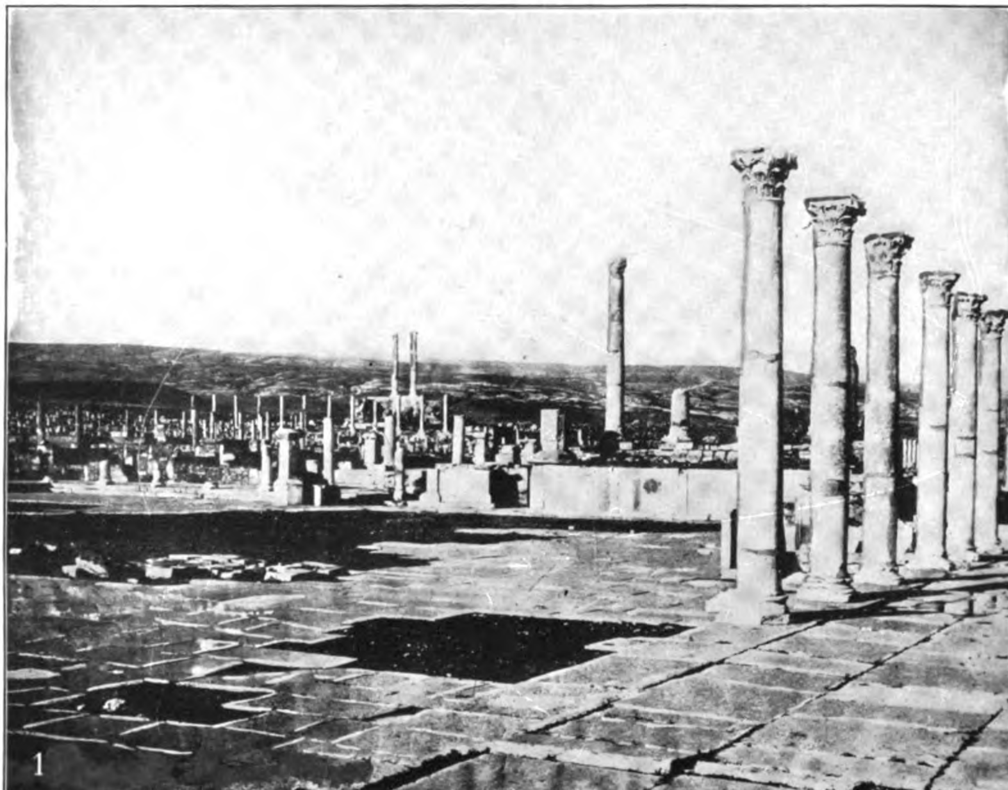
A relation which was of little immediate importance in former generations, but which became very important when railways began to run, was that of the relation of time to longitude. We readily see that, as the earth revolves, the various meridians on its surface are brought into line with the sun. Another way of conceiving the case is to think of noon as continually traveling around the earth from east to west. The rate of motion is one hour for every 15 degrees of longitude. What is true of noon is true of any other hour of the day. Any such hour is about three hours crossing the continent from the Atlantic Coast to San Francisco. The result of this is that if a passenger with a good watch travels westward, he will find his watch continually ahead of the time at the places he reaches. Of course the opposite effect is produced when he travels east. Before 1883 this relation of time was productive of endless confusion on railways everywhere. Conductors could not be changing their watches every minute as they traveled east or west, and thus every railroad had to adopt some meridian as that by which it kept its time. There were, therefore, almost as many meridians as railroads, and passengers frequently missed their trains by not knowing what time to go by.

In 1883 was introduced our present zone system, which is now used over almost the entire country, and is rapidly being introduced into Europe. This system consists in dividing the country into zones by meridians of longitude, 15 degrees, or one hour apart. The central meridians of the zones used in the United States and Canada are those of 60 degrees west of Greenwich, 75 degrees, 90 degrees, 105 degrees and 120 degrees, known respectively as Colonial or Atlantic, Eastern, Central Mountain and Pacific time. The lines dividing one zone from the next are arranged, as nearly as convenient, to run about midway between these meridians. Within each zone one and the same time is used.

The result of this system is that, so long as a traveler journeys only within a single zone he finds the time to be everywhere the same. But when he crosses the line from one zone to the next, the time suddenly changes by one hour. In traveling from New York to San Francisco he crosses three of the zone lines, so that, on arriving at his destination, the time will be three hours slower than in New York.

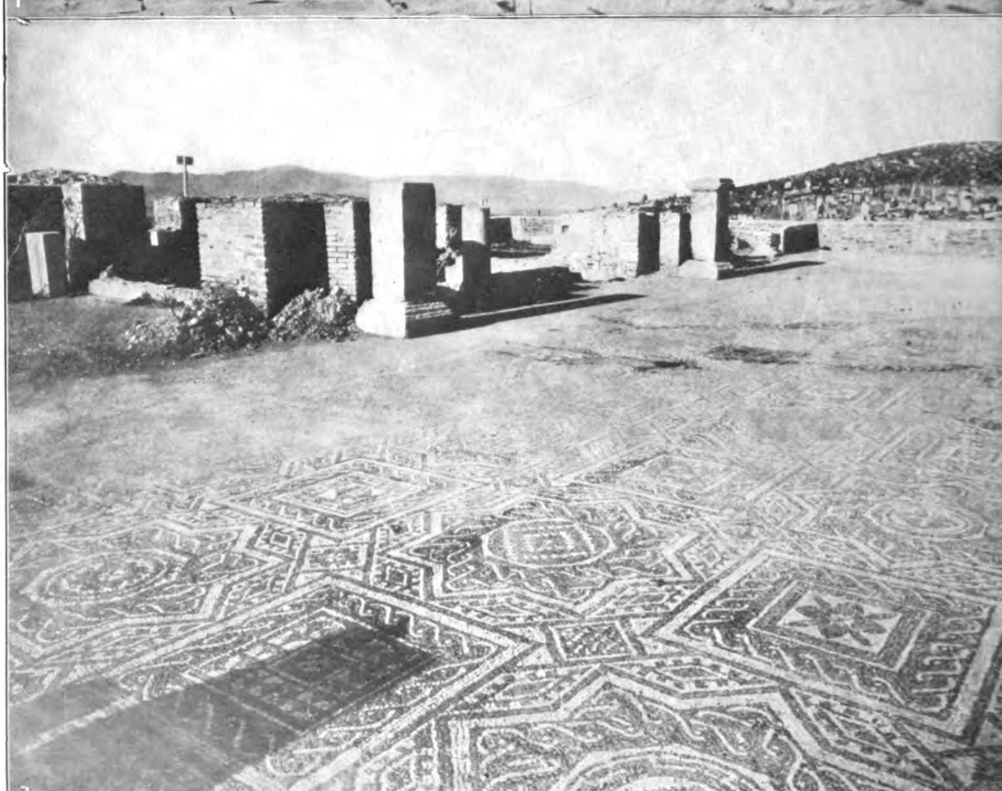
It should be carefully understood that in this system of expressing time, which we now use throughout almost our entire country, the time actually used is not the true time of day, as indicated by the sun, except on the standard meridians. It does not correspond to sunrise or sunset, as given in the almanacs. At midway points, Cincinnati, for example, the time used is necessarily in error by almost half an hour in one direction or the other. But the inconvenience thus arising is very slight. Consequently, if any one determines his time by the passage of the sun across the meridian, he must correct it according to his longitude, from his standard meridian, in order to obtain the stand-

TIMGAD, ALGERIA



1 The Forum and Capitol

2 General View from the Summit of the Theatre



1 The Arch of Trajan

2 Mosaic Pavement in the Court of the Baths

ard time. The inconvenience thus arising is very small compared with the advantages of the uniformity to which the system gives rise.

Similar systems are in use in all European countries except Ireland, Holland, Russia and Greece, which retain the time of their capitals, except in the case of the Russian railroads, which take their time from Pulkova. All other European countries take their time from meridians differing by an integral multiple of 15° or 7½° from that of Greenwich. This is in accordance with the method of reckoning time for international purposes, agreed to by the International Conference held at Washington, D. C., in 1883. Universal time is reckoned from mean noon, the day commencing at midnight, and divided into 24 (instead of into two portions of 12) hours each. Local time will still be used for local purposes; but the method of fixing it will be changed. Since the earth is divided into 360° and the day in 24 hours every 15° will represent the difference of an hour in time. If the earth be divided into 24 equal parts, at every 15th meridian, and if the local mean noon of such meridians be adopted as the standard noon of all places 7½° each side of it, it will follow that when it is noon at Greenwich and at all places within 7½° of Greenwich, it will be 11 o'clock by local (but still noon by universal) time for all places between 7½° and 22½° west of Greenwich, and 13 o'clock by local (but still noon by universal) time for all places between 7½° and 22½° east of Greenwich, and so on throughout the world. Universal time will be the same universally, and local time will differ from it only by even hours, instead of by the various odd minutes by which local standards differ from each other at the present time; while in no case will the difference between standard noon and absolute noon at any place exceed half an hour, since a difference of 7½ degrees of longitude equals a difference of half an hour in time.

Time Signals.— Many observatories send out time signals either daily, hourly or sometimes continuously every second, or every other second, to various parts of the country for the purpose of giving accurate time to all sorts of industries. They are sent out over the telegraph lines, the wires being permanently run into the observatories for the purpose, and the signals are generally sent automatically by a distributing clock which is kept as near the exact time as possible. An electric current passes through the clock and is broken or closed regularly by a toothed wheel on the second hand arbor of the clock. Perhaps the best known set of time signals is that sent out by the Naval Observatory at Washington. It is as follows: three or four minutes before noon, whenever the telegraph companies switch in the loops to the observatory, the clock begins to send out make-circuit signals every second over the various lines, the minutes being indicated by leaving out the seconds 55, 56, 57, 58 and 59 in each, and the half minutes by leaving out the 29th second of each. The click following such a one-second gap then always indicates the beginning of a half-minute and the first following a gap of five seconds indicates the beginning of a minute, except at the exact noon. Just before this there is a gap of 10 seconds, and then exactly at noon the circuit closes and remains closed for just a whole second, the beginning of the marks indicating exact noon. The closing for a whole second is in order to make sure that that particular mark goes through all the telegraph lines, for this particular signal is made to do a great many things at different places, such as the dropping of time balls, and it is more important that this particular second be distinctly sent than any of the others. After the break at the close of the noon signal the telegraph companies quickly switch out the loops to the observatory, and the lines immediately resume their normal work. In the city of Washington this particular noon signal drops a time ball on the top of the State, War and Navy Department Building, and it also automatically corrects, by setting forward or back exactly to 0 hours 0 minutes 0 seconds, all the clocks in the department buildings of the government, no matter how much they may have gained or lost since the preceding noon.

In recent years an artifical regulation of time consists in arbitrarily setting forward all public clocks by the amount of one hour on the first of May of each year, the hour being again dropped in the month of October. The principal advantage of this proceeding is that during the summer months the time of artificial lighting is lessened, with a consequent large aggregate saving in expenditure. Up to the year 1916, this regulation had been adopted in England, Germany, France, Austria, Holland, Denmark, Norway, Italy and Portugal. It was adopted as a war measure in the United States in 1918–19, but was repealed in the latter year.

TIMGAD, Algeria, the ancient Roman city THAMUGADI, in the department of Constantine, near Lambèze, about 25 miles southeast of Batna on the Philippeville-Biskra Railroad, is approached through a valley bounded by the Aures Mountains and stands on the northern fringe of the African Desert. It was a fortified frontier town at the junction of six roads, and was founded in 100 A.D. by Lucius Munatius Gallus. It flourished for three centuries and then underwent various vicissitudes, owing to native insurrections and the incursions of the Vandals, in 535 being partially destroyed. Four years later, under the Byzantine general Solomon, it was restored and had another period of prosperity until the Arab invasion of 646, when the Christian governor, Gregory of Timgad, was defeated and killed, the town being subsequently abandoned, falling into ruins and gradually becoming buried beneath the desert sands. Recent excavations undertaken by the French government have revealed ruins, which for beauty, architecture and magnificent extent have gained for Timgad the title of the «African Pompeii.» Nearly the whole of the city has been laid bare (see illustrations) and exhibits the usual Roman platting, two main streets, the Decumanus Maximus extending east and west and the Cardo Maximus intersecting at right angles, upon and around which the city was built. The principal buildings are on the main streets and among the prominent civic features are the magnificent triumphal arch of Trajan, the Forum (seating 3,500), with the theatre, basilica, library and other buildings surrounding it, the temple of Jupiter Capitolinus, statues of the Roman emperors, a Byzantine fort, the Christian basilica and cathedral erected by Gregory, the governor already mentioned, houses and stores, markets and annexes, thermæ and latrinæ. The arch of Trajan, the finest Roman construction of its kind in northern Africa and the dominating attraction of Timgad, bears an inscription which translated reads:

"The Emperor Cæsar Nerva Trajan Augustus Germanius, son of the divine Nerva, sovereign pontiff, four times tribune, three times consul, father of his country, founded the Marcian colony, Trajan of Thamugadi, by the help of the third Augustus Legion, Lucius Munatius Gallus being the legal imperial proprietor."

The epigraphic wealth of the city is considerable, including inscriptions to early Christians, showing that they were persecuted and underwent martyrdom, while others bear such historical names as Novatus, a member of the Council of Carthage in 258; Sextus in 320; Faustinius, opponent of Gaudentius the Donatist, in 411, and Secundus, bishop of Numidia, exiled by Huneric in 484. Consult Ballu, A., 'Guide Illustré de Timgad' (Paris 1911).

TIMOLEON, tĭ-mō'lē-ŏn, Grecian commander and liberator of Sicily: b. Corinth, about 400 to 395 B.C.; d. Syracuse, 337 B.C. He was accused of having caused the death of his brother, Timophanes, the head of the state, and is said to have exiled himself from Corinth for 20 years in consequence. Little is known of his life until he entered the service of the Greek cities of Sicily in the effort to expel their Carthaginian invaders, an undertaking in which he met with signal success. In 343 he drove Dionysius from Syracuse and in 339, with only 12,000 men, met and conquered a force of 70,000 Carthaginians and allies under Hasdrubal and Hamilcar, at the Crimissus. Thereafter he secured a treaty by which the Carthaginians were confined to the territory east of the Halycus. In the cities thus freed from their enemy, he restored democratic government, and was looked upon as the defender of their liberties. In Syracuse he not only restored ancient rights, but gave its citizens a new and yet more liberal constitution. Consult Plutarch's 'Lives.'

TIMON, tī'mōn, Athenian misanthrope: b. near Athens. He flourished in the later part of the 5th century B.C., and the ingratitude of his friends so greatly embittered him that he retired into solitude. His name has become proverbial as descriptive of a misanthrope. He formed the subject of a famous dialogue by Lucian and his story is familiar through Shakespeare's tragedy.

TIMON OF ATHENS. Very little has yet been discovered concerning 'Timon of Athens.' There is no record of any early performance or any edition other than the strangely imperfect one in the folio of 1623. On the evidence of style the play is dated about 1607 and thus referred to the same period as the three other tragedies with which it has most in common, 'King Lear,' 'Antony and Cleopatra' and 'Coriolanus.' It is generally agreed that the best parts of Timon are not only Shakespeare's but must be counted among his highest achievements in poetry — "poetry," as a recent writer has said, "coming short of 'Lear,' perhaps in poignancy of diction and certainly in pathos of situation, but surpassing even 'Lear' or 'Coriolanus' in the sheer force of that emotion which, in different forms, is common to the three plays" (Wright). On the other hand, many of the un-Shakespearean scenes are of almost unaccountable poorness, by no means justifying Masefield's verdict that they were written by "a man of genius, a skilled writer for the stage, and of a marked personality." The best supported modern view is that something over half the play is by Shakespeare and the rest the unintelligent addition of an unknown reviser. Fleay thought that the Shakespearean fragment was hastily expanded in 1623 for the express purpose of making it fill a gap in the Folio volume, caused by the decision to remove 'Troilus and Cressida' from the number of tragedies. One of the sources is certainly the brief account of Timon in Plutarch's 'Life of Mark Antony,' whence Shakespeare derived most of his material for 'Antony and Cleopatra.' This may have been supplemented by a similar, but much longer narrative in Painter's 'Palace of Pleasure.' The introduction of incidents not found in either of the foregoing works seems to establish the use also of an anonymous earlier Timon play (a comedy), and perhaps of Lucian's dialogue of Timon. There are yet unsolved difficulties about explaining how the last two writings became known to Shakespeare, for the Timon comedy seems neither to have been printed in Shakespeare's day nor to have been acted in London, whereas Lucian's dialogue was not accessible in English. In 1678 the Restoration dramatist, Thomas Shadwell, brought out a revision of 'Timon of Athens,' of which he boasted, "I have made it into a play." The claim may be allowed, for Shadwell's play had reasonable success and there exists no positive proof that 'Timon of Athens' had ever been acted previously. A later adaptation, made by Richard Cumberland in 1768, was acted by Garrick in 1771. Cumberland omitted large portions of the original, added the character of Evanthe, Timon's daughter, romanticized that of her lover, Alcibiades, and much lightened the gloom of the play's close. This piece was a failure. Horace Walpole remarked sardonically that Cumberland's alteration was "marvellously well done, for he has caught the manner and diction of the original so exactly, that I think it is full as bad a play as it was before he corrected it." The best recent discussion of 'Timon of Athens' is by E. H. Wright ('The Authorship of Timon of Athens,' 1910).

TUCKER BROOKE.

TIMOR, tē-mōr', an island of the Malay Archipelago, the most eastern and largest of the Lesser Sunda Islands, 700 miles southeast of Borneo and 500 miles west by south of Papua or New Guinea; length, 300 miles; width, 60 miles; area, 12,450 square miles. Coasts are steep and generally difficult of access on account of coral reefs; the island is traversed by a mountain chain everywhere giving evidence of volcanic origin; one peak, Mount Atlas, is over 12,000 feet; the interior is very little known. The vegetation is less luxuriant and less varied than in the other islands of the East Indies. The coast lands are cultivated to some extent, the northern part of the island being more favorable to agriculture than the southern. Coffee, rice, sugar and cocoanuts are grown, but mostly for domestic use; some coffee is exported, also sandalwood, wax, trepang and tortoise shell. Horses, ponies and cattle are raised and a few exported. There is considerable mineral wealth, but it has not been developed. The people are mainly Papuan, with Malayan, Polynesian and Negrito mixture, with a few Chinese, who control the trade. Many of the people are savage, being classed as «headhunters.» The island politically is divided between Portugal and Holland, the northern part (7,350 square miles) being Portuguese, the southern part (5,120 square miles), Dutch. This division was first made by treaty in 1859, and the boundaries and relationship of the two countries more exactly defined by another treaty in 1893. In 1908 another treaty was ratified and some territory exchanged between these governments. The Dutch capital is Kupang (9,000 pop.), the Portuguese Dilli (3,000 pop.). The Portuguese population of the island (1915) was 378,000; the Dutch between 200,000 and 300,000; but only a few hundred of these are Europeans.

TIMORLAUT, tē-mōr'lowt, also called TENIMBAR, a group of islands of the Malay Archipelago, lying about 300 miles east by north of Timor Island and 150 miles west by south of the Aru Islands, all being southwest of New Guinea. The group consists of Yamdena (or Timerlaut), 1,151 square miles in area, Selaru, Larat, Vordat, Molu and Maro and a number of small uninhabited islands, with a total area of over 2,000 square miles. The larger islands are hilly, the maximum elevation being 820 feet; the others are low and flat, of coral formation. Agriculture is carried on in a primitive fashion; some cattle are raised; turtle fishing is an industry of some importance, and turtle and trepang are exported. The population is estimated at 20,000, mostly Papuans.

TIMOTHEUS, Athenian general: b. about the end of the 5th century; d. Chalcis in Eubœa, about 354 B.C. In 378 he was made commander of the fleet sent out by the Athenian Confederacy to gain the alliance of the Peloponnesian cities and of those along the coast of Laconia, and defeated a Spartan fleet in 375. Peace having been declared with Sparta, he was recalled to Athens. In 372, having been sent to the coast of Asia Minor to aid the satrap of Phrygia, he secured the island of Samos, and by the further acquisition of Sestus and Crithote gained for Athens the control of the Hellespont. In 356 he was appointed, with Chares and Iphicrates, to the command of an expedition against Byzantium, but, refusing to engage in a battle in what he deemed an unpropitious moment, he was accused by Chares of causing the Athenian defeat, and was deposed from power.

TIMOTHEUS, tĭ-mō'thē ŭs, Greek dithyrambic poet: d. 357 B.C. He was the most famous lyric poet of his day. An ancient Greek manuscript of about 100 lines of his 'Nomos,' discovered at Abusir, in Egypt, in 1902, is believed to be the oldest Greek writing in existence, and is thought to have been copied in the 3d century B.C. It is in the Attic poetic dialect, display originality in metre and recounts the defeat of the Persians at Salamis. Timotheus was also remarkable as a musician, improving his instrument, the cithera, and displaying a knowledge of harmonic principles. A collection of the fragments of his poems are to be found in Bergk's 'Poetæ Lyrici Græci.' Consult also Smyth, H. W., 'Greek Melic Poets' (New York 1900); Wright, W. C., 'Short History of Greek Literature' (New York 1907).

TIMOTHY, a disciple of Saint Paul: b. in Lycaonia, Asia Minor, probably at Lystra, of a Gentile father and Jewish mother. His father's name is unknown; his mother's was Eunice, his grandmother's Lois. By his mother and grandmother he was early made familiar with the Old Testament Scriptures, and it seems likely that by them also he was first instructed in the Christian faith, which they had probably been won over to on Saint Paul's first missionary visit to Lystra, while Timothy was still very young. When Saint Paul, along with Silas, visited Lystra on his second missionary journey, seven years after the first, Timothy became an active fellow-worker with the apostle, and he accompanied him and Silas in the further course of their mission. Timothy accompanied Paul to Philippi and Berœa; but he is not mentioned as being with Paul at Thessalonica, which the apostle visited after Philippi and before Berœa. He was then left in the last mentioned city alone, but rejoined Paul at Athens, from which city he was sent back to Thessalonica. After remaining there some time he once more joined his master at Corinth. No further mention is made of Timothy till at least five years later, when he is found with Paul at Ephesus on his third missionary journey. From Ephesus he was sent along with Erastus into Macedonia and Achaia to prepare the churches there for the visit that Paul himself was meditating (Acts xix, 22). Timothy met the apostle again in Macedonia, and was among those who preceded him on his journey to Jerusalem. We lose sight of him for the next two or three years; but he appears at Rome with Paul at the time when the epistles to the Colossians, Philippians and Philemon were written. From the third verse of the first chapter of the first epistle to Timothy we learn that Timothy was on one occasion left at Ephesus when Paul went into Macedonia, and it is supposed that this was after Paul had been released from the confinement in which he was placed when he was sent to Rome from Jerusalem. Tradition makes Timothy the first bishop of Ephesus. He is said to have been martyred in the reign of Domitian or Nerva.

TIMOTHY AND TITUS, Epistles to. Pastoral Epistles.—The two letters which purport to have been written by the Apostle Paul to his young friend and assistant Timothy and the letter which in the same way purports to have been written to his fellow-worker Titus are commonly called from the nature of their contents the «Pastoral Epistles.» They sustain so many resemblances to each other that it is simplest and most helpful to treat them as a group, as, indeed, is commonly done.

Arguments as to Paul's Authorship.— Before touching on their contents and significance, it is best to take up the much debated problem of their authorship. External evidence in favor of Paul's having written them, consisting of quotations and citations by name, is abundant from the earliest times, going back, in fact, to Polycarp and Ignatius (before 120), if not to Clement of Rome (95). The one case of rejection, that by Marcion, is plausibly explained on the ground of antagonism to the doctrines taught. This strong attestation caused them to be unhesitatingly accepted as from Paul down to about the beginning of the last century, but since that time scarcely any point in New Testament criticism has been more constantly and strenuously disputed, and at present there is no point on which critics who deserve consideration are more evenly divided. (1) The first objection to be noted is that these letters cannot be from Paul's pen because the circumstances implied do not agree with the conditions otherwise known to have existed at any time in the apostle's life. It is admitted on all sides that there is no period described in Acts into which these letters fit, but the latest criticism, under the influence of Harnack, holds that Acts was written before the end of Paul's imprisonment at Rome and, if so, it is as legitimate to hold that he was released as that he was put to death soon after the time reached in the story of Acts. This release is rendered plausible by the facts that there was no charge against him on which he could have been fairly condemned (cf. Acts xxvi, 32); that Paul certainly not only hoped but expected release (Phil. i, 25; Philemon 22); and that what ancient tradition exists on the subject is to the effect that he visited Spain as he earlier intended, which would imply release from his first imprisonment. The question of the genuineness of these letters must be settled apart from this point. (2) Another argument against the Pauline authorship is that the vocabulary, the formation of the sentences and the way in which they are related to each other vary irreconcilably from Paul's acknowledged writings. A difference on these points must certainly be recognized, but when we consider the difference in the topics discussed, the lapse of time, which, if not more than five years since the composition of Philippians, might have brought many new circumstances to influence language, and the possible freedom with which Paul's amanuensis may have reproduced what he gave out, it is held by many critics of acuteness and standing that the differences may be harmonized with Pauline authorship. It is interesting to note in this relation that it has lately been urged that the language and style of the «Pastorals» approach in many points those of Luke and that, as it is said in 2 Timothy that he was Paul's only companion when that letter was written, it is presumable that he put that letter on paper, and if so, almost certainly the other two, a fact which would go far to explain the differences under consideration. It is also to be taken into account that the peculiarities of vocabulary and style are equally, if not more, difficult to explain on the theory that the letters were fabricated in direct imitation of Paul's genuine letters, since such a literary artist would naturally have avoided such striking deviations from Paul's previous usage as are recognized to exist. (3) It is also urged that the doctrinal content of these Epistles is inconsistent with Paul's teaching in other letters, and it should be recognized that a difference at least in the form of presentation of truth actually exists. But when it is taken into account that the opponents of Pauline authorship commonly hold that these letters were written by a «Paulinist,» probably by a disciple who felt that he was merely reproducing his master's ideas, it must also be recognized, as it generally is, that no doctrinal contradiction or essential inconsistency exists between the two types of teaching. When the variations in Paul's presentation of his theological views in his acknowledged Epistles, as in 1 Thessalonians, Galatians, 1 Corinthians and Colossians, are taken into account, it should equally be recognized that in the circumstances presupposed in these Epistles Paul might have given the teaching which stands in them. (4) It is also insisted that the conditions which are implied as existing in the churches, alike as to heresies and as to church government, require a later date than can fall in the lifetime of Paul. But it is answered that the government of the churches is by no means so advanced as is sometimes asserted, and that there is no ground for denying that this stage of ecclesiastical development and also such a prevalence of error as is implied, might have been reached by the year 65. (5) It is also objected that the tone of these letters is more formal and distant than it is in the other Epistles, though they were sent to churches; that directions are given to Timothy which are unnatural, as in relation to affairs at Ephesus when Paul had himself just been on the ground, as is implied in 1 Timothy, or when he urges his leaving his work immediately, as in 2 Timothy, and that it is inconceivable that Paul should have addressed Timothy as a youth and a weakling. In answer it is argued that the letters, especially 1 Timothy and Titus, were in reality «open letters,» intended to be read to the churches at Ephesus and in Crete; that 1 Timothy i, 3 does not imply that Paul had himself been lately at Ephesus; that as Timothy might be unavoidably delayed in leaving at Paul's request, directions might well be given to apply in case of such hindrance; that it is not unnatural that Paul, who years before had called himself «the aged,» should still think of Timothy as a youth, it being a not uncommon characteristic of elderly men to think of men of the next generation as more youthful than they really are; and that it is by no means unreasonable to hold that Timothy may have needed the strengthening and heartening of the appeals in these letters, as Paul the strong may personally have been especially drawn to him by the very traits which would show as weakness when he had to live his own independent life as a church leader. It is also to be noted that almost every one of these points tells as strongly against the supposition of fabrication, since a fabricator would naturally avoid these difficulties, and, in particular, would not have inserted anything which might seem to reflect discreditably upon Timothy.

Critical Conclusion.— So far as the above contentions are concerned, it may reasonably be held that neither side has advanced decisive arguments, but that, while the character of the letters does not demonstrate Paul's authorship, on the other hand, the letters have not been proved to be by another hand. Perhaps it should also be remarked that many critics who do not accept Pauline authorship for the letters as they now stand find themselves obliged to recognize that many of the historical notices, especially in 2 Timothy, are genuinely Pauline. Various attempts have been made to show how these fragments could have been woven into documents otherwise fabricated, but thus far all attempts to give a plausible explanation of such an unparalleled literary phenomenon have failed, and it is to be recognized that, in view of the acknowledged relationship of these letters to each other, any attestation of one, as this of 2 Timothy, in some sense attests them all. In the end the decision of the problem of the genuineness of these letters will probably be found to depend on the weight to be given to their acceptance and attestation by the early Church, and it may be said to be true to-day as it was in the time of the Muratorian Fragment (perhaps 175): «An Epistle to Titus and two to Timothy, written out of personal feeling and regard, are still honored in the respect of the Catholic Church in the arrangement of ecclesiastical discipline.»

Occasion and Order of Epistles.— If not Pauline, critics hold that these letters were worked up to confirm the traditional views of the Church against errorists of the author's own time, many holding that 2 Timothy was first composed on the basis of genuinely Pauline memoranda, so to speak, and on this theory, although much later dates have sometimes been suggested, they could hardly have been written after 100 or before 80, while the place of composition would be absolutely indefinite. If accepted as written by Paul, all is much clearer. 1 Timothy was written to Timothy at Ephesus to strengthen him in his position as representative of Paul in the superintendency of the churches, probably in 65 or 66; Titus was written presumably soon after to Titus, who was in Crete in a position similar to Timothy's, to advise and confirm him in his work; and 2 Timothy was sent perhaps in 67 from the prison in Rome where Paul lay chained and facing death not remotely, to express to Timothy his thoughts in view of this situation, and to urge him to come to Rome as soon as possible.

Value.— If these epistles are not genuine Pauline letters, they yet have a certain value as testifying to the conditions in the Church during the last decades of the 1st century in regard to both erroneous thought and needed methods of administration. If genuine, they have a much greater value still as setting forth the last thoughts of the great Apostle in reference to dangerous errors of the time and the importance of both right thinking and right living, and, above all, his thoughts in view of death, constituting what we might call his last will and testament for the benefit, not of Timothy alone, but of the Church universal.

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David Foster Estes,
Professor of New Testament Interpretation, Colgate University.

TIMOTHY. See Grasses in the United States.

TIMROD, Henry, American poet: b. Charleston, S. C., 8 Dec. 1829; d. Columbia, S. C., 6 Oct. 1867. After study at the University of Georgia and some legal education, he was for a time a tutor, at the outbreak of the Civil War became war correspondent of the Charleston *Mercury,* and in 1864 was made assistant editor of the *South Carolinian* at Columbia. The destruction of Columbia by Sherman was the ruin of his occupation, and his subsequent career was unfortunate. Just previous to the war-time, Timrod and P. H. Hayne (q.v.) were brilliant members of that Southern literary coterie in which W. G. Simms was the most prominent. In 1860 a small volume of his poems appeared, but with little recognition. Done under unfavorable conditions, Timrod's poetry has many excellent qualities, and in some cases attains real elevation. Among his best pieces are 'At Magnolia Cemetery'; 'Charleston' and 'The Cotton Boll.' A memorial to him was placed in Washington square, Charleston, in 1901. His verse was collected and published, with a biographical sketch, by Hayne in 1873. An edition, with memoir, in 1899, was followed in 1901 by the so-called memorial edition.

TIMUQUOMAN FAMILY, a group of American Indians formerly occupying central and northern Florida. In 1527 — when first known to the Spaniards — these Indians had some 50 settlements along the Saint John's River. There were five original tribes speaking as many dialects. Wars of other tribes and the inroads of the English from Carolina gradually reduced the tribes in numbers, and they fled to Volusia County, at the headwater of the Saint John's. The territory thus abandoned was afterward occupied by the Seminoles (q.v.).

TIMUR, tē-moor' **(TIMUR BEG, TIMUR LENG, TAMERLANE,** the latter a corruption of Timur Leng, «Timur the Lame»), Mongol conqueror: b. Kesh, near Samarcand, about 1336; d. Otrar, 17 Feb. 1405. He was a descendant of Genghis Khan and became chief of his tribe in 1370, having previously reigned jointly for some years with his brother-in-law, Hussien, of whom he became jealous and whom he put to death, after defeating him in a short civil war. He established a firm government in his dominions and then embarked on his career of conquest. He subdued Persia and the whole of central Asia from the Great Wall of China to Moscow, and in 1398 invaded India, which he mastered from the Indus to the mouth of the Ganges. His cruelty knew no bounds. On one occasion, it is recorded, he massacred 100,000 prisoners, while on the banks of the Ganges he was called by the emperor of the East and other princes to aid in repelling the Turks under Bajazet. He wrested Syria from the Mamelukes on his return journey, overran the sultan's dominions with his vast army and on 20 June 1402 met Bajazet on the plain of Angora, routed his immense army and took him prisoner. In 1404 he began preparations for an expedition into China, and early in 1405 began the advance which was stopped by his death. Timur, however, was not a mere barbarian. He was an able administrator, with many statesmanlike traits, a patron of science and art and is also reputed to have been an author, though on dubious evidence. Consult Howorth, 'History of the Mongols'; Jean de Bec, 'Tamburlain' (1586; Eng. trans., 1595); Malcolm, 'History of Persia.'

TIN, a hard, white, ductile metal, obtained by smelting tin-stone or cassiterite — so-called from the Cassiterides, islands from which it was first brought into European markets. Tin appears to have been known in the time of Moses; and at a somewhat later period in Jewish history it was brought by the ships of Tarshish from the islands east of the Persian Gulf. The Phœnicians traded largely in the tin ores of Cornwall, which was then, as now, celebrated for its mineral wealth. The mountains which separate Galicia from Portugal were also very productive of tin in ancient times, and still continue unexhausted. The mountains between Saxony and Bohemia have been wrought as tin mines for several centuries and still continue productive. Mines of it occur in the Peninsula of Malacca, in India, in Chile, in Mexico, in Peru, etc. Large deposits of tin-stone have been discovered in Queensland, New South Wales and Tasmania.

Tin-stone.— Tin-stone or tin dioxide (SnO_2) is the only ore used for obtaining metallic tin. Its chemical composition is oxygen 21.4 per cent, tin 78.6 per cent. It is found disseminated throughout the alluvium of valleys or in lode at considerable depths beneath the surface; the former deposits yield what is called stream-tin, while from the latter mine-tin is obtained. The first process to which the ore is subjected is grinding. The ground ore is then washed, which removes the impurities; for the specific gravity is so high that it is easy to wash away the earthy matter, and even some of the foreign metallic ores with which it is often mingled. But there are other bodies so nearly of the same specific gravity of the tin ore that they cannot be thus removed. The ore is then roasted in a reverberatory furnace, whereby most of the sulphur and arsenic are expelled. The ore, thus freed as much as possible from foreign matter, is mixed with from 15 to 20 per cent of its weight of pulverized anthracite coal and a small proportion of flux, generally limestone, and heated strongly in a reverberatory furnace, so as to bring the whole into the state of fusion which is kept up with gradually increasing temperature for about eight hours. The lime unites with the earthy matters still mixed with the ore and flows with them into a liquid slag, while the coal reduces the oxide of tin to the metallic state. The reduced tin falls by its own weight to the bottom, and is, at the end of about eight hours, let out by tapping a hole in the furnace which had been filled with clay.

Refining Process.— The tin thus obtained is still very impure; it contains generally iron, copper, arsenic and tungsten. In order to purify it the blocks of tin are placed in a reverberatory furnace and moderately heated to the point where the tin melts and flows into the refining basins, while the greater part of the foreign metals remains in the solid state. The molten tin in the refining basins is then stirred with poles of green wood, whence gases are given off, and the metal is maintained in a state of artificial ebullition. The upper parts of the contents of the basin are oxidized and removed from the surface, while the greater part of the foreign metals collects at the bottom. The metal is allowed to partially cool, during which process it separates into zones, the upper part consisting of nearly pure tin, while the under is so impure that it must be returned to the furnace and again melted. The upper layer of tin is removed into molds, containing each about three hundredweight, in which it is allowed to solidify; it is then sent into the market as block-tin, the purest specimens being called refined tin.

Characteristics.— Tin, when pure, has a fine white color like silver but with a slightly bluish hue, and when newly melted its brilliancy is great. It has a slightly disagreeable taste, and emits a peculiar smell when rubbed. Its hardness is between that of gold and lead. Specific gravity, 7.28. It is very malleable; tin leaf, or tin-foil as it is called, is about one one-thousandth part of an inch thick; and it might be beaten out into leaves as thin again, if such were wanted for the purposes of art. Its ductility and tenacity are much inferior to those of most of the metals known in early times; a bar of tin a quarter of an inch in diameter will not support a greater weight than 294 pounds. Tin is very flexible and produces, while bending, a remarkable creaking noise, known as the «cry of tin.» It melts at about 460° F. When cooled slowly it may be obtained crystallized in the form of a rhombodial prism. By washing the surface of a mass of tin with warm dilute aqua regina it becomes covered with a number of crystals, which, from their unequal action upon light, give an appearance to the metal somewhat resembling that of watered silk. After a short exposure to the air tin loses its lustre and assumes a grayish-black color, but undergoes no further alteration. Neither is it sensibly altered by being kept under water. When cooled to 54° below zero it undergoes a transformation into what is called «gray tin.» In this form it is very brittle and has lost all its metallic properties. When tin is melted in an open vessel its surface becomes very soon covered with a gray powder, which is an oxide of the metal. If the heat be continued the color of the powder gradually changes, and at last it becomes yellow.

Tin Ores.— These are but two in number, tin ore and tin pyrites, known respectively by the technical names of cassiterite and stannite. The first of these occurs crystallized, and in a great variety of forms, which may all be derived from an octahedron with a square base, the angle over the apex being 112° 10′. The majority of the crystals have the general figure of a right square prism, with four-sided pyramids at each extremity. They occur often in twin form, the twin crystals forming an elbow. The cleavages take place parallel with the sides of this prism and with both its diagonals. The crystals may be cleaved also parallel to the sides of the above-named octahedron, but with difficulty. The prisms are sometimes vertically streaked. Lustre adamantine; color various shades of white, gray, yellow, red, brown and black; streak pale gray, in some varieties pale brown; semi-transparent, sometimes almost transparent, and in others opaque; brittle; hardness six to seven, about that of feldspar, specific gravity, 6.96. Tin ore presents itself in a great variety of compound or macled crystals. It also occurs reniform, rarely in botryoidal shapes, and massive, with a granular or columnar composition, the individuals being strongly connected and the fracture uneven. The wood-tin of the Cornish mines is a mere variety of tin ore. It is so-called because of its resemblance to a cross section of the trunk of a tree, with the concentric rings of annual growth. In color it is dark reddish to brown. The following ingredients were found in specimens of crystallized, massive and wood-tin ore:—

	Crystallized	Massive	Wood-tin
Oxide of tin........	99.00	95.00	85.14
Oxide of iron......	0.25	5.00	13.42
Silica.............	0.75	0.00	1.03

In its greatest purity cassiterite contains nothing but oxide of tin. Alone it does not melt before the blowpipe, but is reducible when in contact with charcoal. It occurs disseminated through granite, also in beds and veins, in lode mines. It also occurs in the beds and alluvial deposits of streams in the form of rolled pebbles and is extracted in this shape as «stream-tin» by placer works and dredges. The variety called wood-tin has hitherto been found only in these repositories, but is occasionally found in pockets in rock formations. Tin pyrites ($Cu_2S.FeS.SnS$), the other ore of tin, occurs massive, with a granular composition; fracture uneven, imperfectly conchoidal; lustre metallic; color steel-gray, inclining to yellow; streak black; opaque; brittle; hardness about that of fluor-spar; specific gravity, 4.35. Before the blowpipe sulphur is driven off and the mineral melts into a blackish scoria, without yielding a metallic button. It is soluble in nitro-muriatic acid, with precipitation of part of the sulphur. It contains from 14 to 30 per cent of tin. It is found at Saint Agnes in Cornwall, in Saxony and in Bolivia and in Virginia, Idaho and Montana in the United States.

Production.— The world's production of tin in the calendar year 1916 amounted to 135,-360 short tons. Of this total, 49,130 tons (about 36 per cent) came from the Federated Malay States; 23,500 tons from Bolivia; 14,-000 tons from Banca, Dutch East Indies; 9,400 tons from Siam; 8,400 tons from China; 5,980 tons from Australia; 5,680 tons from Nigeria; 5,500 tons from Billiton and Singkep, Dutch East Indies; 5,260 tons from Cornwall, England; 4,900 tons from the British Protected Malay States; 2,100 tons from the Union of South Africa; and 1,500 tons from all other countries. About 33,000 tons were lode tin — from Bolivia, Cornwall, South Africa and Australia — and the remainder from placer workings. The total is 10,870 tons less than for 1913, just preceding the war. Incomplete figures indicate that the output for 1917 is about 2,000 tons more than for 1916, in spite of the serious decrease of nearly 5,000 tons from the Federated Malay States; a condition resulting from an increase of 5,800 tons in the output of Bolivia. Although the complete blockade of Germany left that nation's usual consumption, amounting to 21,000 tons annually, free upon the market, the price of tin rose enormously during 1917 — from 44.19 cents per pound in January to 85.35 cents per pound in December. These figures are to be compared with an average price of about 44 cents per pound for the years immediately preceding the war. During the first years of the conflict the price fell below 31 cents.

The contribution of the United States to the 1916 total was about 140 short tons, derived almost entirely from Alaska, and chiefly the product of dredges operating in the York district, in the western part of the Seward Peninsula. The output of this district was 162 tons of «stream tin» estimated to average 60 per cent of metallic tin. Nearly two-thirds of the whole Alaskan output was sent to Singapore to be smelted and refined. The United States output for 1917 was but 90 tons. Nearly all of the production is from placer workings, the one lode mine worked being the Lost River mine, in Alaska. The other tin producing localities in the United States are in Lander and Humboldt counties, Nevada; the Black Hills in Pennington County, South Dakota; near Lincolnton in North Carolina; near Gaffney, South Carolina; and in the Franklin Mountains, north of El Paso, Texas. In all of these localities the ore is cassiterite. This ore has been found in small quantities also in the Temescal Mountains of California, near Corona — a deposit which produced 135 tons of tin in 1890–91; in Virginia, in Rockbridge and Nelson counties; in Washington, at Silver Hill, near Spokane; in Maine, at Winslow, and several other localities; and in New Hampshire, at Jackson. Wood-tin has been found in the gold-bearing gravel of Panther Creek, Idaho; and in the Big Prickly Pear Creek district of Montana. There was in 1916 but one smelter in the United States handling tin ores, the plant of the American Smelting and Refining Company at Perth Amboy, N. J. Its capacity is about 14,000 tons of tin per year and it works almost solely upon Bolivian concentrates. Before the war a large percentage of the Bolivian tin concentrates was sent to Germany for smelting. With the cessation of this service a large smelting plant was built in Chile and another plant erected in the United States.

In 1917 there was imported into the United States for consumption a total of 77,866 short tons of metallic tin, having an aggregate value of $68,603,439. Thus it appears that the United States consumed nearly 57 per cent of the entire world's output of tin for the year.

Uses.— The principal use of tin in the United States is in the production of tin-plate for the manufacture of tinware and of terne-plate for roofing and building purposes. In terne-plate the tin used to plate the iron sheets carries a percentage of lead. Tin is used also in the manufacture of cheap mirrors, the «silvering» compound consisting of an amalgam of tin and mercury. It is also used largely in the technical arts in various alloys; as in Britannia metal, type metal, solder, pewter, bell metal and several bronzes.

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TIN HORN WAR. See UNITED STATES, THE WARS OF THE.

TIN-MOUTH, a fish. See CRAPPIE.

TIN PLATE, Manufacture of. The manufacture of tin plate was probably begun in Bohemia, about the beginning of the 16th century, and was first attempted in England about 1670. The early crude methods consisted of the simple expedient of dipping the plates of iron into a vat of molten tin and allowing the surplus metal to drain off. In 1865 Mr. Morewood, of South Wales, England, invented a machine which gave tin plate manufacture its start, greatly reducing the cost of production. At the surface of the pot he placed a pair of steel rods which seized the plate as it came up and rolled off the superfluous tin; thus leaving the coating of the plate smooth and even. Since then many improvements have been made in the methods of manufacture, making the product more serviceable and reducing materially the manufacturing expenses. The modern method is as follows:

After the bars of steel have reached the rolling mill they are first cut into accurate lengths, then placed in the sheet-mill furnace, brought to a cherry-red heat, taken out in pairs and given three or four passes through roughing rolls, each bar being fed through sidewise and rolled singly. After cooling they are again heated, placed one upon the other, and in pairs are again rolled. The doubler then grasps the plates at one end with a pair of large tongs and brings the two ends together. The loose ends are then shorn off square, and the fold is flattened by means of a powerful press, thus making four thicknesses or plates, one end of each being free, the other still forming the bend. The plates are again heated, passed through the roughing rolls, taken by the doubler, opened back to the bend, and once more doubled. The first bend is snipped off when the ends are squared, thus making one free end for each sheet in the pack. This is done to prevent buckling and to insure a perfect finished plate. They are then heated for the fourth time, passed two or three times more through the finishing rolls and are then ready for the pickler.

After the sheets have been separated and examined for possible flaws, they are sent to the black pickler, where they are immersed in a strong solution of acid and hot water to remove all dirt, after which they are rinsed and allowed to drain. All perfect plates, in order to make them sufficiently soft for general use, are sent to the annealing furnace, which opens the pores and toughens the plate. After being heated there thoroughly for a period of about 12 hours the plates are cooled off and carried to the cold rolls through which they are passed singly. The re-squarer then trims the four edges and restacks the plates in the annealing box; they are again annealed and put into the white pickler, in which the acid solution is much weaker than in the first bath.

Having been pickled and rinsed, the plates are placed in water boshes; immersed in a bath of melted palm-oil; placed in a pot containing molten tin and lead; and finally dipped into another pot of tin of lower temperature than the previous one. From the tinning pot they are put into the grease pot, the thickness of the coating being determined by the length of time they remain therein. After cooling they are cleaned by passing through bran and dust. This completes the process and the plates are ready for the market.

According to the census of 1905 there were in the United States 36 establishments engaged in the manufacture of tin plate, employing $10,813,239 capital and 4,847 persons; paying $2,383,070 for wages and $31,375,714 for materials; and having an aggregate output valued at $35,283,360. The business has largely increased since, and the present method of figuring the production is by boxes. Of these the production in 1914 was 20,271,683, 1915 22,925,437, 1916 26,979,994 and 1917 32,898,597. The tremendous increase, due to war orders, cannot be maintained unless there is an increase in the production of tin, which is not expected.

Consult Louis, H., 'Metallurgy of Tin' (1911); Schnabel, C., 'Handbook of Metallurgy' (2d ed., 2 vols., London 1905–07).

TIN WEDDING. See WEDDING ANNIVERSARIES.

TINAMOU, a South American game-bird, the *Crypturi*, called «partridge» by European colonists because of its superficial likeness to those birds, but structurally occupying a distinct place, the determination of which has greatly puzzled ornithologists. The view now prevails that they are a «very distinct group of birds, which though not to be removed from the *Carinatæ* present so much resemblance to the *Ratitæ* as to indicate them to be the bond of union between those two great divisions. Many genera and species are known in southern South America and two or three forms extend northward into Mexico. They vary in size from that of a quail to a guinea hen. The head is small, neck slender, bill elongated and plumage close and inconspicuous, usually brownish or bluish, with few ornamental markings. The wings are short and rounded, and the tail so short and soft as in some species to appear absent altogether. Some of them inhabit forests and others more open country, and show very little skill or courage in avoiding the gun or escaping capture. Their flesh is delicious. They nest upon the ground and lay very remarkable eggs, since the shell «looks as if it were of highly burnished metal or glazed porcelain, presenting also various colors, which seem to be constant in the particular species, from pale primrose to sage-green, or light indigo, or from chocolate brown to pink-orange.» The fact that the male alone incubates the eggs is one of many ratite characteristics of this antique and curious group of birds. Consult Newton, 'Dictionary of Birds' (New York 1896) wherein will be found many references to special authorities.

TINCAL, or TINKAL, a common trade name for borax (q.v.) in the crude state.

TINCKER, Mary Agnes, American novelist: b. Ellsworth, Me., 18 July 1833. In her earlier days she taught in a Roman Catholic parochial school and from 1873 to 1887 lived in Italy. Her best known novel is 'Signor Monaldini's Niece' (1878); others are 'By the Tiber' (1881); 'The Jewel in the Lotus' (1884); 'Aurora' (1885); 'Autumn Leaves' (1898).

TINCTURE, *in pharmacy,* an alcoholic solution of some medicinal substance, prepared by digestion, maceration or percolation. It may be a solution of some chemical element as iodine, of some single chemical compound as chloride of iron, or a solution of that part of some plant which will dissolve in the solvent used: example, tincture of cinchona bark. Simple tinctures are those obtained from a single drug, compound tinctures from many. The solvents (*menstrua*) are various; pure alcohol, mixtures of alcohol and water or of alcohol and ether, alcoholic solutions containing ammonia, etc.

TINDAL, Matthew, English controversialist: b. Beer Ferris, in Devonshire, about 1653; d. 16 Aug. 1733. He was graduated from Lincoln College, Oxford, in 1676, in 1678 was elected a Fellow of All Souls' College, and afterward became a Doctor of Civil Law, and an advocate of Doctor's Commons. In the reign of James II he turned Roman Catholic, but in 1688 returned to the Church of England. He published several pieces, political and theological, among which were a 'Letter to the Clergymen of the two Universities, on the subject of the Trinity and Athanasian Creed,' and a treatise, 'The Rights of the Christian Church asserted against Priests' (1706). This work excited a sensation among the high church clergy, who attacked it with great vigor. Tindal published two defenses of it, which the House of Commons ordered to be burned by the common hangman, with the original treatise. In 1730 he published his 'Christianity as Old as the Creation, or the Gospel a Republication of the Religion of Nature,' in which his object was to show that there cannot be any revelation distinct from the internal revelation of the law of nature in the hearts of mankind. This deistical or rationalist work — by which his name is chiefly known — received a great many answers.

TINDALL, or TYNDALE, William, English reformer and translator of the Bible: b. near Welsh borders, about 1490; d. Vilvoorden, Belgium, 6 Aug. 1536. He entered the University of Oxford in 1510, and was graduated in 1512. He subsequently went to Cambridge, where he resided till 1521, and about this latter date became tutor to the children of Sir John Walsh, a landed gentleman in Gloucestershire. He preached with great acceptance in the neighborhood, but soon got into trouble owing to his unorthodox views. In 1523 he went to London, where he came under the influence of Luther's teaching. It was at this time that he began his translation of the New Testament, but finding it unsafe to carry out such a work in England, he went to Hamburg in 1524, and immediately afterward to Luther at Wittenberg, where he remained till April 1525. During this time he was proceeding with his translation, with the assistance of one William Roy, and the printing of it was begun at Cologne in 1525. A Roman Catholic clergyman, John Cochlæus, came to know of this, and obtained an injunction ordering the stoppage of the work, whereupon Tindall went to Worms and had the work printed there. It was smuggled into England in 1526, and at once Archbishop Warham and Bishop Tunstall took the lead in seizing and burning copies. Attempts were also made to get hold of Tindall, but he fled to Marburg, where he enjoyed the protection of the landgrave of Hesse. Here he became a Zwinglian in his attitude on the Eucharist, and published some of his most important original works, including The Parable of the Wicked Mammon' (1528); 'The Obedience of a Christian Man,' and 'How Christian Rulers Ought to Govern' (1528), and 'The Practyse of Prelates' (1530). He also engaged in a vigorous polemic with Sir Thomas More. From Marburg he went to the Netherlands, and for several years resided in Antwerp, but toward 1533 left the city for a time, owing to Henry VIII's efforts to seize him. In 1535 he was captured at Antwerp by the imperial officers, assisted by an English Roman Catholic student named Phillips who professed to adopt his reforming opinions. He was lodged in the state prison at Vilvoorden, near Brussels, and despite some efforts to save him, made by Cromwell and others, he was tried for heresy, condemned, degraded from holy orders, then strangled and his body burned. A fragment of the interrupted Cologne print of his New Testament translation is in the British Museum, and there are two extant copies of the first edition of his complete New Testament (1525), one (practically complete) in the Baptist College, Bristol, the other (incomplete) in Saint Paul's Cathedral. A revised edition was issued by him at Antwerp in 1534, and a further revision in the following year. His translation of the Pentateuch appeared at Marburg in 1529–30, and that of Jonah at Antwerp in 1531; a copy of each is in the British Museum. Tindall's translation is of much importance in the history of the English style and English literature, and formed the basis, as far as it went, of the Authorized Version of nearly a century later. There is an edition of Tindall's original works by the Parker Society (3 vols.; 1848–50). Consult Demaus, 'Life of William Tindall' (1886); Price, I. M., 'Ancestry of Our English Bible' (Phila. 1907).

TINDER, a dry substance that readily ignites from a spark; before the introduction of friction matches, it was in common use as a means of starting a fire. It consisted usually of charred linen which caught the spark from a flint and steel; since the tinder did not flame, the fire was started by touching a match dipped in sulphur to the ignited tinder. Tinder-boxes were boxes in which tinder was kept ready for use; they were usually provided with a flint and steel, the latter often fastened to the cover of the box in such a manner that the flint when struck against it sent sparks into the tinder within. «German tinder» or amadou consisted of the more solid portions of certain fungi, mainly tree-growing polyfores, prepared by boiling in water and drying. Sometimes saltpetre, or even a little gunpowder, is added. Amadou has been used to stop bleeding and also in surgery as a support and for pressure and protection. «Spanish tinder» was a stuff prepared from the pubescence of the flower-heads, stems and leaves of globe-thistle. The use of the word tinder has been extended to denote any substance easily inflammable.

TINEIDÆ, a family of moths, prominently represented by several small species whose caterpillars are destructive to woolen fabrics, furs and various stored products. See CLOTHES-

MOTH; FLOUR AND MEAL INSECTS; GRAIN INSECTS; MOTHS, etc.

TINGLEY, Katherine, American theosophist: b. Newburyport, Mass., 6 July 1852. She married P. B. Tingley in 1889. She was for some years an assistant to W. Q. Judge, who with H. P. Blavatsky were active in establishing theosophy as a philosophy and religion and on his death she founded, 18 Feb. 1898, a new branch called the Universal Brotherhood and Theosophical Society, which has branches in many cities and countries and headquarters at Point Loma, Cal. She has edited *Century Path* for a number of years and has written 'The Mysteries of the Heart Doctrine' (1902); 'Nosegay of Everlastings' (1913); 'Theosophy and Some of the Vital Problems of the Day' (1915). See THEOSOPHY.

TINOCERAS, tĭ-nŏs'ē-ras, a genus of mammals now extinct, found in the Eocene of Wyoming (Bridger beds) and representing the order *Dinocerata*. The individuals were all large, some of them nearly equaling the elephants, and differed little from, if, indeed, they were not identical with, *Uintatherium.*

TINOS, tē'nōs, or **TENOS,** tē'nŏs, Greece. an island in the monarchy of the Cyclades, immediately southeast of Andros. It is 18 miles long by eight miles broad and has an area of 81 square miles. It is traversed by high mountains, the terraced slopes of which yield wine, wheat, melons, figs, etc. Marble and silk goods are the chief exports. Tenos or Hagios Nikolaos, the chief town, on the south coast, is the see of a Roman Catholic bishop, has two Roman Catholic churches and a small harbor. North of the town is the white marble church of Penagia Evangelistria, a famous pilgrim resort. Excavations in 1902 on the site of ancient Tenos revealed remains of the temple of Poseidon. Tenos was prominent in the wars with the Persians and during the Greek Revolution 1821–27. Pop. 12,000.

TINTERN ABBEY, England, a ruin of unrivaled beauty in Monmouthshire, on the Wye, eight miles south of Monmouth. It was founded in 1131 by the Cistercian monks — the church in 1287. It is well preserved and is a noble specimen of the transition from Early English to the Decorated. The open work of the windows is one of its chief beauties. Under Henry VIII the abbey was dismantled and its lands bestowed upon the earl of Worcester.

TINTERN ABBEY, 'Lines Composed a Few Miles above Tintern Abbey, on Revisiting the Banks of the Wye during a Tour, July 13, 1798' a reflective poem in 159 lines of blank-verse, by William Wordsworth, was composed in 1798, and was published that same year in the famous volume entitled 'Lyrical Ballads.' The clumsy title has long since been shortened by the public to 'Tintern Abbey'— in itself misleading, since the poem has nothing to do with the abbey, which is used simply to identify the landscape that serves as a basis for the poet's reflections. Wordsworth had visited the region alone and on foot in 1793; upon his second visit, five years later, he recalls the first and compares his feeling for nature at that time with what it is now. His theme in general is the inter-relation between nature and the spirit of man, each as an interpreter and revealer of the other: the contemplation of nature gives an insight into the invisible world that comprehends both nature and man; nature has the power to throw light upon the mystery of human life; she can console and sustain; man's own emotional experiences, in turn, reveal and interpret nature. Primarily reflective, 'Tintern Abbey' is at the same time intensely subjective, and hence is almost as lyrical in essence as Wordsworth's so-called 'Ode on Immortality,' with the ideas of which it has so much in common. The two in both thought and style are Wordsworth's greatest poems; each complements the other; and taken together they form the *locus classicus* of the Wordsworthian faith and doctrine. The Platonism that informs the 'Ode,' though less fundamental to 'Tintern Abbey,' yet colors the latter throughout.

The poet distinguishes three successive periods in his attitude toward nature: his first, and merely animal delight, grows into a sensuous appreciation of natural beauty, and this in turn finally develops into a moral and contemplative attitude and brings the «philosophic mind» that identifies nature, man and God (compare 'The Prelude,' Book VIII, lines 340–356). Perhaps none of the ideas in the poem, taken singly, was new to the world; but certainly never before had they been fused into a whole and stated with such impressiveness and splendor as the utterance of one great personality. The style of the poem, though it undeniably drops toward the end in the poet's address to his sister, is in the main superb. Here is Wordsworth's «grand manner,» as in the 'Ode,' no less appropriate and perfect in its way than the beautiful simplicity of his 'Michael' (q.v.). No other of his poems contains so many of his most felicitous lines, such as

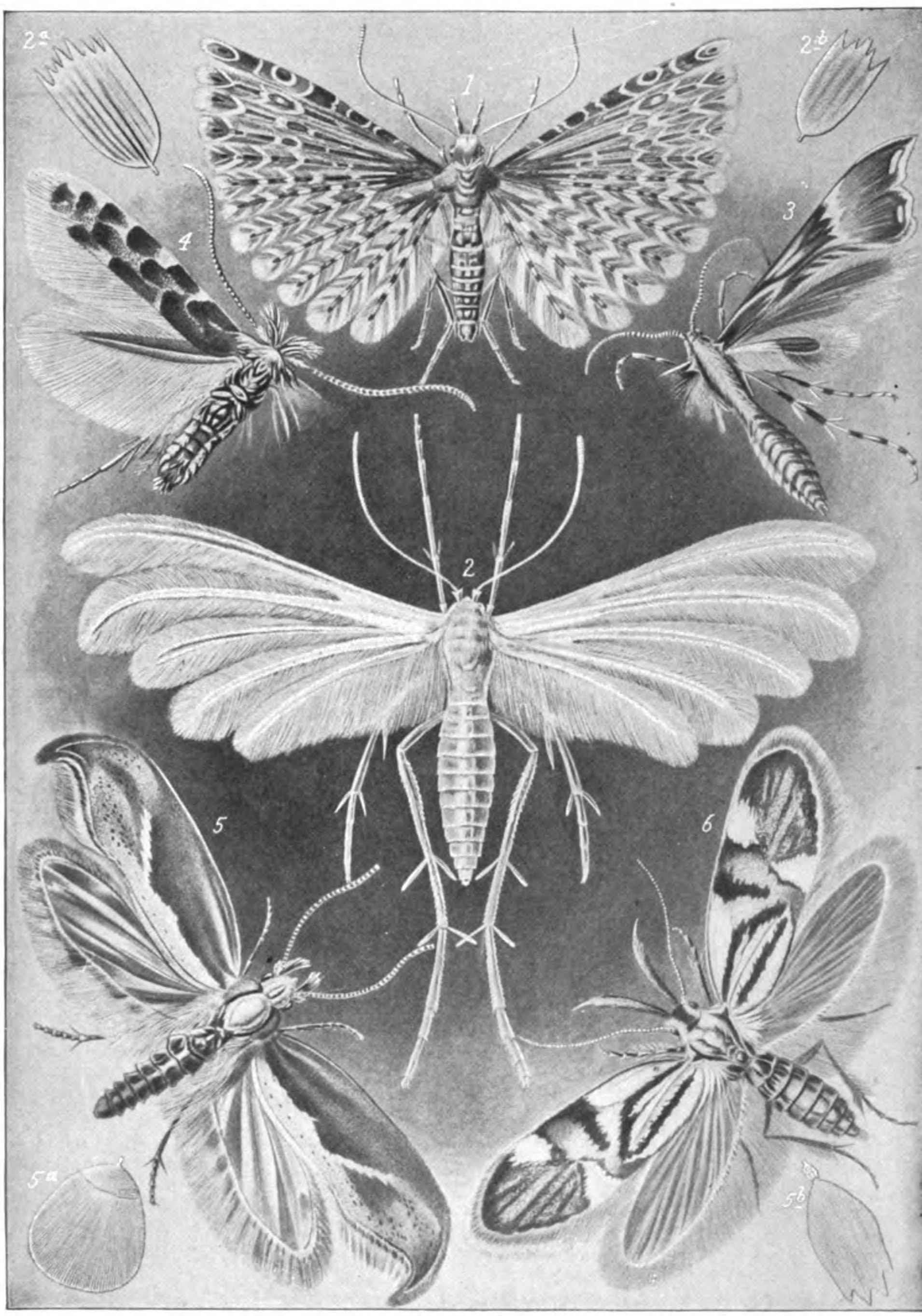
"the still, sad music of humanity",
"the little, nameless, unremembered acts of kindness and of love",
"nature never did betray the heart that loved her".

Its faith in the entire beneficence of nature is of course the obvious weakness of the poem considered philosophically. How far 19th century theories and discoveries have invalidated its teaching cannot be discussed here. It is doubtful whether the average reader is at all affected by Wordsworth's failure to see the other side of nature, by his lack of scientific vision. Here he speaks simply as a seer; and the passage in which he declares his sense of the Power «whose dwelling is the light of setting suns» is perhaps as moving and sublime as any in the whole range of English poetry, as incomparable, at least in style, as anything in Shakespeare or Shelley. Whether considered as the self-revealing utterance of a great personality, or as the statement of a doctrine that has immensely influenced the course of modern poetic thought, or simply as an example of magnificent diction, 'Tintern Abbey' has a permanent place among the supreme achievements of modern poetry.

MARION TUCKER.

TINTORETTO, tēn-tō-ret'tō, **Jacopo Robusti,** son of a dyer (Italian, *tintore*), whence his usual surname, Italian painter: b. Venice, 16 Sept. 1518; d. there, 31 May 1594. He was a pupil of Titian, but was soon dismissed by his master, perhaps through fear of rivalry. He thereupon worked without a master, taking as

TINEID MOTHS (much magnified)



1, 2, 3 Feathered Moths 4, 5, 6 Common Moths Other figures are details of the scales

his ideal in painting a union of the design of Michelangelo with the coloring of Titian. He painted with such extraordinary facility and rapidity as to gain the epithet «Il Furioso.» Annibale Carracci said that he was sometimes equal to Titian, often inferior to Tintoretto. He treated Scripture subjects in a perfectly naturalistic spirit, but at times this became decidedly coarse. Ruskin estimates Tintoretto very highly, and places him among the supreme painters. The greater number of his works are to be found in his native city, and of these the following may be named: In the Palace of the Doges: 'Paradise,' the largest oil-painting in the world, with a very large number of figures; 'The Delivery of the Doge's Insignia to Niccolò da Ponte'; 'Recapture of Zara'; 'Forge of Vulcan'; 'Mercury with the Graces'; 'Minerva driving back Mars'; 'Descent from the Cross'; etc. In the Academy: 'Saint Mark descending to the Rescue of a Condemned Christian Slave'; 'Adoration of the Kings'; etc. In the church of Madonna dell' Orto: 'The Last Judgment'; 'Adoration of the Golden Calf'; 'Miracle of Saint Agnes,' and 'Presentation in the Temple.' The Uffizi gallery at Florence contains some of his works, including 'Abraham's Sacrifice' and a 'Marriage at Cana'; and the Pitti Palace contains among others, a 'Descent from the Cross'; 'Vulcan with Venus and Cupid,' and a 'Madonna.' The Prado Museum at Madrid is rich in works by Tintoretto, among them being many portraits; and others are to be seen in the National Gallery at London ('Saint George Destroying the Dragon'; 'Christ Washing the Feet of His Disciples'), Berlin, Dresden, Vienna, Paris, etc. Consult Ruskin, 'Stones of Venice'; 'Modern Painters'; etc.; Osler, 'Tintoretto' (1879); Stearns, 'Jacopo Robusti' (1895); and the 'Lives' by Bonsusan (1907) and Philipps (1911).

TINWORTH, George, English sculptor: b. London, England, 5 Nov. 1843. He was the son of a wheelwright and in his father's shop began the practice of wood carving. In 1861 he took lessons in an art school at Lambeth and in 1864 entered the Royal Academy schools. After exhibiting figures and groups of figures at the Royal Academy, he obtained an appointment in the Doulton art pottery (1867). The productions by which he became famous were mainly terra-cotta panels with groups of figures in high relief illustrating scenes from sacred history, which combine originality of design, with dramatic effectiveness and devout feeling. His most important work is the reredos in York Minster, with 28 terra-cotta panels.

TIONONTAIC, an American Indian tribe formerly residing near Nottawasaga Bay, Ontario, Canada. When first discovered by the French in 1616, they were called the Tobacco Nation, from their large fields of tobacco. In 1670, the remnants of the tribe joined the Wyandottes (q.v.).

TIPPECANOE, a nickname of Gen. William Henry Harrison, given to him on account of his victory in the battle of Tippecanoe (q.v.). In the presidential campaign of 1840, which resulted in the election of Harrison and Tyler, «Tippecanoe and Tyler too» was the party war-cry of the Whigs.

TIPPECANOE, Battle of, fought 7 Nov. 1811 near the site of the present village of Battle Ground, on the Tippecanoe River, in Tippecanoe County, Ind., between about 900 Americans under William Henry Harrison (q.v.), who was then governor of the Territory of Indiana and a force of Indians nominally under «the Prophet,» brother of Tecumseh (q.v.), but actually commanded by three chiefs, Stone Eater, White Loon and Winnemac. The Indians were estimated by Harrison at about 6,000, but were probably much less in number. Harrison encamped on the night of 6 November near the Indian village on the Tippecanoe River and while his men were asleep in the early morning of the 7th the Indians fell upon them with great fury and were only defeated and driven from the field after several hours of desperate fighting, in which the whites lost about 185 in killed and wounded, the loss of the Indians being unknown, though they left 40 dead on the field. The village was found on the 8th deserted and was burned by Harrison's men. For reasons of prudence Harrison then fell back to Vincennes. Consult Pirtle, 'The Battle of Tippecanoe' (1900), No. 15 of the «Filson Club Publications.»

TIPPERARY, tĭp-ĕ-rā'rĭ, Ireland, a town and the county-seat of the famous county of Tipperary in Munster. The town is situated 42 miles northwest of Cork and 110 miles southwest of Dublin. It has a large grammar school, several religious schools and butter and provision markets.

TIPPLE, Ezra Squier, American Methodist Episcopal clergyman: b. Camden, N. Y., 23 Jan. 1861. He was graduated at Syracuse University in 1884, took his Ph.D. there in 1886 and was graduated at Drew Theological Seminary in 1887. He served as a pastor in New York in 1887–1905, when he became professor of practical theology at Drew Theological Seminary. Since 1912 he has been president of that institution. He is a trustee of Syracuse University and is author of 'The Heart of Asbury's Journal' (1905); 'The Life of Freeborn Garrettson' (1910); 'Francis Asbury' (1916); 'The Drew Theological Seminary, 1867–1917' (1917), etc.

TIPPOO (or TIPU) SAHIB, tĭ-poo' sä'-hĭb, sultan of Mysore: b. 19 Nov. 1749; d. Seringapatam, Mysore, 4 May 1799. He was the son of Hyder Ali Khan, whom he succeeded in 1782. During the operations of the English troops under General Mathews in Malabar, he checked the advance of the British at Bednor, April 1783 and temporarily wrested Mangalore from its western invaders. In the following autumn he was compelled to surrender this province to Great Britain. In 1784 he was forced to sign a treaty of peace; but, continuing to intrigue, war was declared against him in 1790 and in 1791 he was defeated by Lord Cornwallis and obliged to surrender half of his domain and to pay 33,000,000 rupees to his English conquerors. In 1799 he was suspected of an alliance with France and again defeated by the British and their allies, the Mahrattas. He was killed while fighting in this campaign. Consult Bowring, 'Haider Ali and Tipu Sultan' (1893).

TIPTON, England, town in Staffordshire, situated six miles northwest of Birmingham. It has coal and iron mines, iron foundries, steam boiler and structural iron works, red and white-lead factories, cement works and brick-yards. Pop. about 32,000.

TIPULIDÆ, the family of craneflies (q.v.).

TIRABOSCHI, tē-rä-bŏs'kē, **Girolamo,** Italian literary historian: b. Bergamo, 28 Dec. 1731; d. Modena, 3 July 1794. He was educated by the Jesuits, afterward joining their order and was for many years a professor in the University of Milan. He was a scholar of note, his greatest work being the 'Storia della Letteratura Italiana' (1772–93) in 13 volumes. He also published 'Biblioteca Modenese' (6 vols., 1781–86), and 'Memorie storiche modenesi' (1793–94). He was librarian to Francis III, duke of Modena, from 1770.

TIRAILLEUR, tĭ-rä-lyėr, a skirmisher, sharpshooter; the title was first employed by the French in 1792, to denote light-armed troops thrown out from the main body to do skirmish work, feel the enemy, cover the movement of the main body, etc.

TIRASPOL, tē-räs-poly', Russia, a river-port in the government of Cherson, on the Dniester, 60 miles northwest of Odessa. It possesses five churches, two synagogues and a state bank. One of its chief attractions is its gardens. The principal industries are tobacco-raising and fruit culture. There are four factories and some trade is carried on.

TIRE, the outer band placed around the felloes of a wheel, made in various forms, for several purposes. The common tire for a wooden-carriage wheel is made of iron or steel and serves the double purpose of holding together the parts of the wheel and resisting wear in traversing the ground. The continuous steel tire is an American invention and consists of a flat hoop of steel usually of the same width and formed so to fit tightly over the felloes; it is expanded by heating and put on in a heated condition; upon cooling it shrinks and tightly compresses the wheel. It is further secured by sunk-bolts through the felloes. The wire wheel made on a suspension principle, as in the bicycle, has a steel felloe with a concave outer surface for holding a rubber tire or a pneumatice tire. These have been highly developed in the bicycle (q.v.) and the automobile (q.v.); car wheels and locomotive wheels of cast iron or cast steel have usually tires of tough wrought steel shrunk on, so that the wearing surface may be as durable as possible. See RUBBER TIRES.

TIREBUCK, William Edwards, English novelist: b. Liverpool, 1854. He was for some years a writer on the staff of the Liverpool *Mail* and the Yorkshire *Post*, but in 1888 retired from newspaper life and devoted himself to writing fiction. His best-known novels include 'Saint Margaret' (1888); 'Dorrie' (1891) and 'Miss Grace of All Souls' (1895). He is also the author of an estimate of 'Dante Gabriel Rosetti' (1882) and of a later work entitled 'Great Minds in Art' (1888), etc.

TIRESIAS, tī-rē'sĭ-ạs, according to Greek mythology, a soothsayer of Thebes, reputed to have been struck blind either because he had revealed to men things which they ought not to know, or because he had seen Athene bathing. Athene conferred upon him the power to understand the language of birds, while Zeus gave him the gift of prophecy and long life. Tennyson has a poem on the subject of 'Tiresias' (1885), who also figures in many Greek legends.

TIRLEMONT (Flemish, *Thienen* or *Tienen*), Belgium, town in the province of Brabant, on the Geete River, 11 miles southeast of Louvain and 29 miles east of Brussels. There are two churches dating from the 12th century, Notre Dame du Lac and that of Saint Germain. Saint Germain has a fine altar-piece by Wappers. The town was taken by the Duke of Marlborough in 1705; on 16 March 1793 it was the scene of a victory by the French over the Austrians, and in the European War it was occupied by the Germans soon after the outbreak of the war in 1914, remaining in their hands until the armistice. Industries include brewing and the manufacture of leather, woolens, soap and engines. Pop. 17,581.

TIRPITZ, Alfred von, German admiral: b. Kustrin, 1849. Graduating from the Marine Academy when only 17 years of age, he advanced rapidly, and in 1896 was State Secretary of the Navy and in 1898 Minister of State of Prussia. In 1911 came his promotion to the post of Lord High Admiral. He took great interest in the development of the submarine and had immense faith in this arm of the navy. He is credited with having organized and planned the submarine blockade of the British Isles in 1915–16. When he carried his policy to the extent of sinking unarmed vessels, culminating in the torpedoing of the *Lusitania* (q.v.), he aroused such indignation in neutral countries that the unwisdom of the policy was apparent and his resignation was arranged for, though the assigned reason was his illness. See WAR, EUROPEAN.

TIRYNS, tĭ'rĭnz, Greece, in Argolis, 10 miles southeast of Mycenæ, an ancient city on a rocky height which formed the Acropolis; beneath which another city extended along the plain. The town was destroyed 468 B.C. Much of the citadel and of the cyclopean walls with their pointed gates are still standing, together with some interior passages or galleries of similar construction. The excavations conducted by Schliemann in 1884–85 resulted in the discovery of a magnificent palace, comprising various buildings and approached by a peristyle. The complete arrangement of public halls and private apartments is apparent. Consult Schliemann, 'Tiryns' (1886); Perrot and Chipiez, 'Histoire de l'Art dans l'Antiquité' (Vol. VI, 1894) and Baedeker's 'Greece.'

TISCHBEIN, tĭsh-bīn, **Johann Friedrich August,** German painter: b. Maestricht, 1750; d. Heidelberg, 1812. He studied with Johann Heinrich Tischbein and in Paris and Italy. After serving as court painter in Waldeck he became director of the Leipzig Academy in 1800. He painted many noteworthy portraits, including nine of the princes and princesses of Orange-Nassau (Amsterdam) and that of Schiller, which he finished in 1804.

TISCHBEIN, Johann Heinrich, German painter: b. Haina, 3 Oct. 1722; d. Cassel, 22

Aug. 1789. He studied under the court painter Freese in his native town and under Boucher, Van Loo and Watteau in Paris. He entered the studio of Piazzetta in Venice 1748, returned to Cassel in 1751, was made court painter to the landgrave and in 1776 became director of the New Academy. He painted numerous portraits and historical pictures, which, although not possessing great strength, were considered among the best produced in Germany at that period. Among them may be mentioned 'Lessing' (1760); 'Count Waldner von Freundstein' (1761); 'Augustus and Cleopatra' (1769), and 'Belisarius' (1786).

TISCHBEIN, Johann Heinrich Wilhelm, German painter and etcher, called «the Neapolitan»: b. Haina, 15 Feb. 1751; d. Eutin, 26 July 1829. He was a nephew of Johann Heinrich Tischbein and the most famous of the Tischbein family. He studied under his uncle and other relatives and in Hamburg, Bremen and Holland. Goethe assisted him in going to Italy and in 1787 the two went together to Naples, where Tischbein enjoyed the patronage of Sir William Hamilton and from 1789 to 1799 was director of the Academy. In 1809 he became court painter to the Duke of Oldenburg. The 43 'Idyls' celebrated in Goethe's verse were painted by Tischbein at Eutin. To different publications he contributed over 150 etchings and engravings and his paintings include 'Conradin of Swabia Hearing his Sentence' (1784); 'An Italian Landscape' (1819); a portrait of Goethe, and a portrait of the artist himself. Consult Michel, 'Etude biographique sur les Tischbeins' (1881).

TISCHENDORF, tĭsh'ĕn-dŏrf, **Konstantin von,** German biblical critic: b. Lengenfeld, Saxony, 18 Jan. 1815; d. Leipzig, 7 Dec. 1874. He was educated at Leipzig, where he qualified as a lecturer in 1840. In the latter year he went to Paris and deciphered the 'Codex Ephræmi' and soon afterward he began to travel extensively in Europe, Egypt, Sinai and Palestine in search of biblical manuscripts. In 1844 he saved from the flames in the Convent of Saint Catharine on Mount Sinai a valuable manuscript of the Old Testament, but failed to get possession of more than a part of it. This part he published in facsimile in 1846 as the 'Codex Friderico-Augustanus,' so named in honor of his patron, the king of Saxony. He was appointed in 1845 extraordinary professor, in 1850 ordinary honorary professor and in 1859 ordinary professor of theology and biblical palæography at Leipzig. He again visited the East in 1853 and in 1859 he made a third visit at the cost of the Russian government. On the third journey to Sinai he brought back the rest of his 'Codex Friderico-Augustanus,' better known as the 'Codex Sinaiticus,' the oldest Greek manuscript of the Bible, containing the entire New Testament and the Epistle of Barnabas, besides much of the Old Testament. (See CODEX SINAITICUS). A magnificent facsimile edition was published in four volumes at Saint Petersburg in 1862. In 1869 Tischendorf was ennobled by the emperor. Among his contributions to the textual criticsm of the New and the Greek Old Testament are 10 editions between 1843 and 1870, the largest being 'Monumenta Sacra Inedita: Nova Collectio' (1855–70). He issued several editions of the Greek New Testament, of which the eighth critical edition (two vols., 1864–72) is of great importance. In his 'Novum Testamentum Triglottum' (1854) he printed together his Greek text, the Latin of Jerome and the German of Luther. His 'Synopsis Evangelica' (5th ed. 1854) should also be mentioned in connection with this part of his work. He edited the Septuagint with critical appendix (1850; 7th ed. 1887) and on the New Testament apocrypha and pseudepigrapha published 'De Evangeliorum Apocryphorum, Origine et Usu' (1851); 'Acta Apostolorum Apocrypha' (1851); 'Evangelia Apocrypha' (1853); and 'Apocalypses Apocryphæ' (1866). 'In wann wurden unsere Evangelien verfasst?' (1865; Eng. trans.) he shows a strongly conservative tendency. He described his travels in the works 'Reise in den Orient' (1845–46) and 'Aus dem Heiligen Lande' (1862).

TISHRI, a month in the Jewish calendar. the first of the civil year and the seventh of the ecclesiastical. It corresponds to portions of our September and October and contains the Jewish Day of Atonement as well as the Feast of Tabernacles. It is frequently mentioned in the Old Testament and in 1 Kings xiii, 2 it is related that «. . . all the men of Israel assembled themselves unto King Solomon at the feast in the month Ethanim, which is the seventh month»; the term Ethanim, used instead of Tishri, signifies streaming rivers, the result of the September floods. The name tishri occurs in the Palmyrene inscriptions and, therefore, was probably not confined to the Jews.

TISSANDIER, tē-sän-dē-ā, **Gaston,** French aeronaut: b. Paris, France, 21 Nov. 1843. He was the inventor of a dirigible balloon in which he made an ascent of five and one-third miles, from Paris in 1875; he alone surviving of the members of the aeronautic experiment. Besides his written contributions to the subject of aeronautics he has contributed to the 'Library of Wonders' series, well-known volumes on the subjects of light, water, coal and fossils.

TISSERAND, François Félix, French astronomer: b. Nuits-Saint-Georges, Côte-d'Or, 15 Jan. 1845; d. Paris, 20 Oct. 1896. He was educated at the École Normale Supérieure and in 1866 he became adjunct professor at the Paris Observatory. He took his doctor's degree in 1868 with a thesis which was a brilliant extension of the scope of the method of Delaunay. He went to Malacca to observe the solar eclipse of 18 Aug. 1868 and in 1873 became director of the *Observatory* at Toulouse. He was a member of the French expeditions observing the transit of Venus, in Japan, in 1874 and in Martinique in 1882. He was elected to the Academy of Sciences in 1878; in 1883 became professor of celestial mechanics at the Sorbonne; and in 1892 was appointed director of the Paris Observatory. He made many valuable investigations in the field of celestial mechanics and wrote brilliantly on the subject. The results of his own labors and that of others in this field are set forth with masterly grasp and simplicity in his 'Traité de mecanique celeste' (4 vols., 1886–96). He revised Lalande's catalogue and was editor of the *Bulletin Astronomique.*

TISSOT, tē-sō, **Claude Joseph,** French philosopher: b. Fourgs (Doubs), 26 Nov. 1801; d. Dijon, 7 Oct. 1876. He translated the larger part of Kant's writings into French. Among his original works are 'Of the Beautiful, Especially in Literature' (1830); 'Short History of Philosophy' (1840); 'The Mania of Suicide and of Revolt' (1840); 'Parceling of the Land and Division of Property' (1842); 'Principles of Morality' (1866); 'Catholicism and Public Instruction' (1874); 'Insanity Considered Especially in its Relations to Normal Psychology' (1876).

TISSOT, James, French painter: b. Nantes, 15 Oct. 1836; d. Abbey of Bouillon, 8 Aug. 1902. He was a pupil of Ingres, studied in London under Seymour Haden, and attracted attention by his brilliant pictures of fashionable women, actresses and grisettes, as in his 'Promenade in the Snow' (1859). His series of etchings 'Parisian Women' was very popular. He suddenly changed his whole artistic aim in life under the stress of a sudden bereavement and went to Palestine (1890) where he studied for six years the scenery and buildings and rural activities of the Holy Land for the purpose of producing a set of pictures illustrating the life of Christ. These paintings were subsequently reproduced by Lemercier in Paris under the title 'La vie de notre Seigneur Jésus-Christ'; and a parallel publication of them has been issued in this country. The original drawings and paintings, 540 in all, are now in the Brooklyn Institute of Art. Just before his death he began his paintings illustrating the Old Testament.

TISSUE, *in biology,* a group of similar cells in an animal body (or a plant) which form a definite fabric, having the same origin and discharging the same function. Tissues are classified according to their structure when completely developed, in accordance with their functions, or with reference to their mode or origin. A common classification of animal tissues includes cellular tissue, connective tissue (q.v.), epithelial tissue (see EPITHELIUM), muscular tissue (see MUSCULAR SYSTEM, DEVELOPMENT OF), nerve-tissue (see NERVOUS SYSTEM, EVOLUTION OF THE), etc. Fatty tissue consists of a meshwork of white fibrous tissue in which fat-cells are imbedded. It is found beneath the skin, around various internal organs, in the marrow of bones, and elsewhere, and is both protective and heat-retaining in its function. Mucous tissue is merely a stage in the development of ordinary connective tissue. Adenoid tissue, found in the glands, consists of a network of very delicate connective tissue, in which white cells of various sizes are entangled. The cartilage (q.v.) or gristle of the joints is one of the primary animal tissues. See ANATOMY, COMPARATIVE; PLANTS, STRUCTURE OF; BONE; CARTILAGE; HISTOLOGY; PARENCHYMA.

TISSUE PAPER. See PAPER; PAPER INDUSTRY IN AMERICA.

TISZA, tĭs'ŏ, **Koloman Borosjeno von,** Hungarian statesman: b. Grosswardein, 16 Dec. 1830; d. Budapest, Hungary, 23 March 1902. He was educated for the law, but entered the civil service in 1848, and took a prominent part in educational affairs. Although not at first identified with the revolutionary movement, the attempt of Austria to control ecclesiastical matters in Hungary in 1859 brought him forward as the leader of the party which stood for Protestant autonomy. In 1860 he was elected to the Hungarian Parliament, where he opposed the conciliatory measures offered by the imperial government in the proposal to relinquish absolute authority and to yield the right of representation to the Magyar provinces, and stood resolutely and persistently for independence. In 1861 he succeeded Count Telsky as the leader of the Constitutional party. He was subsequently instrumental in uniting the moderate Radicals with the Liberal party, but was at all times opposed to the socialistic and agrarian demands of the revolutionists. In 1875 he was appointed Minister of the Interior, and some months later became Prime Minister. He resigned his office in 1890, but continued until his death to direct the affairs of his party and to control legislation.

TISZA, Stephan, COUNT, Hungarian statesman: b. Budapest, 1861; d. 31 Oct. 1918. He was educated at the universities of Berlin, Heidelberg and Vienna and was appointed to a post in the Hungarian Ministry of the Interior in 1882. He was elected to the Hungarian Parliament in 1886, and was conspicuous for his strong support of close relations with Austria. He was Premier and Minister of the Interior in 1903–06, losing his seat in Parliament at the same time that his ministry fell. He was again appointed Premier 10 June 1913, and occupied that office at the outbreak of the European War in 1914. He was thoroughly in sympathy with the war and was regarded as one of its chief authors. Growing dissatisfaction with the continuation of the war, and overwhelming demands for suffrage and other reforms which Tisza was unwilling to grant resulted in efforts to bring about the fall of his Cabinet in 1917, and he resigned 13 May 1917. In 1918 he was assassinated.

TITANIA, according to Ovid, a name of Latona, a daughter of the Titan Coius. Shakespeare in 'Midsummer Night's Dream,' gives the name to the wife of Oberon.

TITANIFEROUS IRON ORES are chiefly varieties of the minerals ilmenite, hematite and magnetite. Ilmenite (q.v.) is often called titanic iron ore and is richer in titanium than either of the others. The value of these ores for both iron and titanium, which was long questioned, seems at last to be established. The remarkable attraction of titanium for nitrogen suggests its use in freeing iron and steel of blow-holes, while titanium steel is known to possess remarkable toughness and tensile strength. Much excellent work has been done by Rossi in pointing out the merits of titanium steel and in developing processes for the reduction of titaniferous iron ores. The most important known occurrences of these ores are in Norway, Quebec and the Adirondack Mountains, in each of which regions there are beds of vast extent. These occurrences have been exhaustively described in papers by F. J. Pope and J. T. Kemp.

TITANITE, a mineral occurring in mono clinic crystals, often wedge-shaped and twinned, having the composition of calcium silico-titanate. Its lustre is adamantine to resinous; hardness, 5 to 5.5; specific gravity about 3.5. Parting is often prominent, while prismatic cleavage is less distinct. Its colors vary greatly. Dark brown to black crystals, sometimes several inches in diameter, occur mostly in limestone in Saint Lawrence County, New York, and in Canada. The variety sphene is usually bright green or golden yellow, and often occurs in gneiss or chloritic schists in transparent or translucent twin crystals. Owing to the high refractive and dispersive power of such crystals, gems of rare beauty and inferior to none but the diamond in their play of colors, may be cut from them, though they lack durability owing to their low degree of hardness. The finest of these gem sphenes are from Switzerland, the Tyrol, Delaware County, Pennsylvania and Tilly Foster, New York.

TITANIUM. See ELECTRO-CHEMICAL INDUSTRIES; MINERAL PRODUCTION OF THE UNITED STATES.

TITANOSAURUS, a genus of huge sauropodous dinosaurs. See DINOSAURIA.

TITANOTHERIUM. See BRONTOTHERIUM.

TITANS, tī'tạnz, *in Greek mythology,* six sons and six daughters of Uranus and Ge, namely Oceanus, Koius, Krelius, Hyperion, Iapetus and Kronus; Theia, Rhea, Themis, Mnemosyne, Phœbe and Tethys. Uranus having banished to Tartarus the Hekatoncheires ("the hundred-handed") and the Cyclops, Gaia called the Titans to avenge their brothers. They rose and freed them, deposed Uranus, and set Kronus in his place. Kronus and the Titans were in their turn put down by the sons of Kronus and Rhea, named the Olympii, with Zeus at their head, but not till after a long struggle, in which Zeus brought to his aid the Cyclops and Hekatoncheires, whom Kronus had again imprisoned in Tartarus. Zeus quelled the Titans with the lightning given him by the Cyclops, hurled them to Tartarus, placing them under the care of the Hekatoncheires. This struggle, called the Titanomachia, was regarded as symbolic of the conflict of reason and order with the rude forces of nature. Consult Mayer, 'Die Giganten und Titanen in der antiken Sage und Kunst' (1887).

TITCHENER, tĭch'ĕn-ẽr, **Edward Bradford,** American psychologist: b. Chichester, England, 11 Jan. 1867. He was graduated from Oxford in 1890, and afterward studied in Leipzig. He returned to Oxford as extension lecturer in biology, but was called to Cornell University, Ithaca, N. Y., in 1892, as assistant professor of psychology, and in 1895 became Sage professor of psychology there. His writings include 'A Primer of Psychology' (1898); 'Experimental Psychology' (1901); 'Text Book of Psychology' (1910); 'A Beginner's Psychology' (1915). He is also editor of the *American Journal of Psychology.*

TITE, SIR **William,** British architect: b. London, Feb. 1798; d. 23 April 1873. He shared in the work of rebuilding the body of Saint-Dunstan-in-the-East in 1817–20; was engaged in building the Scottish Church in Regent square in 1827–28; and was one of the designers of the London and Westminster Bank, Lothbury, in 1838. He rebuilt the Royal Exchange in 1841–44, a work which is considered his greatest achievement as an architect. He designed the earlier English railways stations as well as those on the line from Havre to Paris, France. He planned the Woking Cemetery in 1853–54; was a member of Parliament from 1855 until his death; and was knighted in 1869. Author of 'A Catalogue and Description of the Antiquities Found in the Excavations for the Royal Exchange' (1848).

TITHES, taxes, either voluntary or compulsory, consisting of one-tenth of the income taxed. Usually tithes were one-tenth of the annual profit of the land and were paid for purposes of church support. The custom is of extreme antiquity. In Genesis xiv, 20, Abraham allows a tenth of the spoils taken from four kings to their victor. Moses allowed tithes for the support of the Levites and for service in the temple (Lev. xxvii, and Num. xviii). In 778 Charlemagne commanded tithes to be collected within all the portions of the old Roman empire over which he ruled; this was for the support of the Christian Church. These tithes were by him allotted to four different uses: one part was for the maintenance of the edifice of the church, and the other three, severally, for the support of the bishop, the clergy and the poor. Ecclesiastical tithes were always more or less oppressive in their operation, being unevenly imposed, but after their introduction into Great Britain they were systematized. They were first enjoined in England in 786 and in 794. Offa, king of Mercia, gave the Church all the tithes of his kingdom, and this law was subsequently made general for all England by Ethelwulf. When dioceses were divided into parishes the tithes of each parish were allotted to its minister, at first by common consent, but afterward, about 1200, by the law of the land in England. The custom of paying tithes became established in Germany and France about the same time, the 9th century, and in the Scandinavian countries in the 11th century. At first the payment of the tax was always in kind, that is, in grain, livestock, wool, etc., and such tithes were known under three heads, namely, prædial, or those which arise immediately from the soil, as grain, fruits and wood; mixed, or those consisting of natural products but nurtured by the care of man, as calves, lambs, eggs, cheeses, wool, etc.; and personal, or those arising from the profits of personal industry as in the pursuit of some profession, or some trade of livelihood. With regard to their value tithes were divided into great and small; great tithes being grain and wood, and belonging to the rector, and small tithes being the other prædial tithes with the mixed and the personal tithes, and belonging to the vicar.

Tithes proved a source of great trouble in every country in which they were collected and a constant cause of bickering between the clergy and the people. They have, therefore, been abandoned in nearly all countries except England, where they are still retained. There they have been the cause of constant friction between the people on the one hand and the officers of the law and the clergy on the other. Under Henry VIII, the owners of certain great estates were relieved of the duty and this increased the feeling of the tithe-payers that their burden was an unjust one. In three-fourths of Ireland it was found impossible to collect tithes, for long periods at a time, and the enforcement of the law, especially in cases of non-members of the Church, was not infrequently accompanied by riot and revolt. Finally, an act of commutation was passed by which tithes were assessed in money, the value being based on the average price of corn for a preceding term of years. The matter has been the subject of much legislation by Parliament, which has generally established in lieu of the old system a fixed money rent charge payable annually. Consult Clarke, H. W., 'History of Tithes' (1891); Degge, S., 'The Parson's Counsellor with the Law of Tithes' (1820), and Selden, J., 'History of Tithes' (1618).

TITHING, an old English subdivision of the population. It consisted of a company of about 10 households, one of the integral parts of a hundred (see SHIRE), who were regarded as a distinct political division for some purposes of police and civil regulation. At its head was the tithing-man, who was directly responsible to the officers of the Crown, the several members of the tithing being bound for the peaceable behavior of each other. The institution of the tithing has passed away, the tithing-man has evolved into the police constable, but in some parts of England British conservatism still preserves the name and the corresponding territorial distinction.

TITHING MAN. See TOWN AND TOWN MEETINGS.

TITHONUS, tĭ-thō'nŭs, a son or nephew of Laomedon, king of Troy. He was beloved of Eos (Aurora, Morning), who induced Zeus to make him immortal. Her prayer was granted but she had neglected to ask for perpetual youth, and in time her lover took on all the signs of extreme age. Tithonus prayed to the gods to be relieved of this «cruel immortality» and was metamorphosed into a grasshopper. Tennyson has written a remarkable poem, 'Tithonus,' on this mythological incident.

TITIAN (TIZIANO VECELLI), the greatest painter of the Venetian school and one of the world's greatest painters: b. Pieve in Cadore, a district in the Venetian or Carnic Alps, 1477; d. Venice, 27 Aug. 1576. He was the son of Gregorio di Conte Vecelli, a descendant of an ancient family and a man of some note in his province. It was the custom of this family to follow arms or the law, but young Titian showed such genius for art that at the age of nine or 10 he was sent to Venice to learn painting. He studied under Gentile Bellini and afterward with Giovanni Bellini and then attached himself to Giorgione, who was the idol of the day. Master and pupil worked together on the outside frescoes for the new Fondaco dei Tedeschi, the exchange of the German merchants in Venice. After Giorgione's sudden death by the plague in 1510, Titian completed several of his master's works. Titian's pictures of this period show much similarity to Giorgione's and are often referred to as «Giorgionesque Titians.» One of the most famous is 'Sacred and Profane Love' (in the Borghese Gallery in Rome), about which so much has been written. To this period also belong the 'Virgin and Child' (Vienna Gallery), popularly called 'La Zingarella'; the Bishop of Paphos, or 'Baffo' (Antwerp Gallery); 'Saint Mark' (in the Salute, Venice); the 'Three Ages' (Bridgewater Gallery, England); 'Madonna of the Cherries' (Vienna Gallery); 'Daughter of Herodias' (Doria Gallery, Rome); 'Christ with the Tribute Money' (Dresden Gallery); and 'Noli me Tangere' (National Gallery, London).

In 1511 Titian went to Padua to paint a series of frescoes in the Senola di S. Angelo and returned to Venice in 1513, where he became superintendent of government works and was ordered to complete the paintings left unfinished by Giovanni Bellini in the Hall of the Great Council of the Doge's Palace. Here he painted the portraits of five successive Doges. In 1514 he was invited to the Court of Alfonso, Duke of Ferrara, for whom he painted many charming works, including the 'Worship of Venus' and the 'Bacchanel,' with Ariadne dozing over her wine-cup (both in the Prado, Madrid), and the superb 'Bacchus and Ariadne' (in the National Gallery, London). At Ferrara he formed a friendship with Ariosto and Aretino, whose portraits he painted. In 1516, while painting these delightfully decorative and pagan triumphs of Bacchus and Venus, he began work on the 'Assunte,' or 'Assumption of the Virgin,' for the church of S. Marie Gloriosa dei Frari, Venice (now in the Venice Academy). This was finished in 1518 and created a sensation, for it was considered the most astonishing performance in color on a grand scale that had as yet been executed. The same gallery now preserves the famous 'Presentation of the Virgin,' a large and much restored picture, and one of Titian's masterpieces of masterpieces. In 1526 he completed the 'Pesaro Madonna,' on which he had worked for seven years. This is still in the church of the Frari and represents the Madonna enthroned with adoring saints, including Saint George, and members of the aristocratic Pesaro family beneath the group. The 'Cornaro Family,' belonging to the Duke of Northumberland, is a work of the same general character. The 'Entombment of Christ' (in the Louvre) is another early work, and 'Christ Crowned with Thorns' (also in the Louvre) still shows the influence of Giorgione.

In 1525 Titian married. Nothing is known about his wife, who died in 1530, leaving three children, one the infant Lavinia, of whom Titian painted so many beautiful portraits. Titian now removed to a fine house in the Biri Grande, a fashionable suburb of Venice, where he had beautiful gardens sweeping down to the sea. Here he had his sister do the honors of his establishment and here he entertained lavishly and charmingly. In 1532 he painted a portrait of Charles V, the emperor, in Bologna, and was, in consequence, created a Count Palatine and a Knight of the Golden Spur. His two sons were also made nobles of the empire — a most unusual honor for a painter. From this time onward Titian enjoyed a worldly success greater than that any other painters ever had accorded to them, with the exception of Raphael, Michelangelo and Rubens. In 1540 D'Avalos, Marquis del Vasto, gave him a pension and Charles V an annuity of 2,000 crowns (afterward doubled) on the treasury of Milan. When visiting Rome in 1546 he was given the freedom of the city. In 1550 he painted the famous portrait of Philip II of Spain, which helped his suit for the hand of Queen Mary of England. Notwithstanding the many statements that Titian visited Spain, modern authorities affirm that he never was there. He traveled much in Italy and went to Augsburg and was at the Council of Trent in 1555. In 1565 he went to Cadore to design decorations for the church at Pieve, his native town. He spent most of his life, however, in Venice, where he worked until the last moments of his life. Vasari saw him with brushes in hand painting furiously. Titian was, according to most authorities, 99 when he died of the plague, then raging in Venice. Vasari gives his birth as 1480, but Titian, writing to Philip II in 1571, said he was 95. He was buried in the church of the Frari near his famous painting, the 'Madonna di Casa Pesaro.' Canova's monument now marks his grave. His son, Oragio, died of the plague a few days after Titian. He, too, was a painter, but overshadowed by his father's greatness. In the confusion and riotous days of the plague Titian's splendid villa was entered and plundered by thieves. Titian's last painting was a 'Pieta,' which was finished by Palma Giovine. Although Titian lived in grand style and had many orders, he seems to have had much trouble in collecting his payments; for his correspondence is full of appeals to his debtors. He gave splendid entertainments and attracted the most brilliant men of the age. It is related that when Henri III of France passed through Venice on his way from Poland to take the French throne, he called on Titian with his suite of noblemen and that the painter presented him as a gift with all the pictures of which he inquired the price.

Even allowing for the abnormal length of his professional career, Titian's prolific faculty is amazing. More than a thousand pictures in European and American galleries are attributed to Titian. Of these 250 are spurious or doubtful. The largest collection (41 works) is in the Prado, Madrid. The Uffizi has 18; the Pitti, 16; Naples Museum, seven; the Venice Academy, eight; the Louvre, 18 and the National Gallery, London, six. Some critics accord the famous 'Concert' in the Louvre, which has long been considered a Giorgione, to Titian.

«Titian was a man of correct features and handsome person,» writes William M. Rossetti, «with an uncommon air of penetrating observation and self-possessed composure — a Venetian presence worthy to pair with any of those most potent, grave and reserved signors, whom his brush has transmitted to posterity. He was highly distinguished, courteous and winning in society, personally unassuming and a fine speaker, enjoying (as is said by Vasari, who saw him in the spring of 1566) health and prosperity unequaled. He was not a man of universal genius or varied faculty and accomplished like Leonardo da Vinci and Michelangelo: his one great and supreme endowment was that of painting. Titian may properly be regarded as the greatest manipulator of paint in relation to color, tone, luminosity, richness, texture, softness, surface and harmony and with a view to the production of a pictorial whole converging to the eye, a true, dignified and beautiful impression of its general subject matter and of the objects of sense which form its constituent parts. In this sense Titian has never been deposed from his sovereignty in painting. Titian's pictures abound with memories of his home country and of the region which led from the hill summits of Cadore to the Queen City of the Adriatic. He was almost the first great painter to exhibit an appreciation of mountains, mainly those of a turretted type, as exemplified in the Dolomites. Indeed he gave to landscape a new and original vitality, expressing the quality of the objects of nature and their control over the sentiments and imagination with a force that had never been before approached. The earliest Italian picture expressly designated as 'landscape' was one which Titian sent in 1552 to Philip II. Naturally a good deal of attention has been given by artists, connoisseurs and experts to probing the secret of how Titian managed to obtain such extraordinary results in color and surface. His figures were put in with the brush dipped in a brown solution and then altered and worked up as his intention developed. In his earlier pictures the gamut of color rests mainly upon red and green; in the later ones upon deep yellow and blue. The pigments which he used were nothing unusual; indeed they were both few and common. Palma Giovine records that Vecelli would set pictures aside for months and afterward examining them as if they were his mortal enemies would set to work upon them like a man possessed. Also that he left many pictures in progress at the same time, turning from one to the other, and that in his final operations he worked far more with the finger than with the brush.» Titian seems to have taken Palma Vecchio as his model for softness and Giorgione as his model for richness. He distanced all his predecessors in the study of color as applied to draperies.

Titian excelled in every style. The 'Assumption of the Virgin' is ranked as one of the world's greatest pictures and the 'Entombment of Christ,' the 'Christ Crowned with Thorns' (Louvre), the 'Ecce Homo' (Vienna Gallery), in which Aretino posed for Pilate, the 'Supper at Emmaus' (Louvre), 'Saint Mark' (Salute, Venice), the 'Presentation in the Temple,' 'Christ in the Garden' (Madrid), 'Noli me Tangere' (London) and 'Saint Jerome' (Barera, Milan) attest his power in religious subjects. An exuberant fancy and dash characterizes his delightful mythological production such as 'Bacchus and Ariadne' (National Gallery), 'Bacchenal' and 'Worship of Venus,' 'Diana and Actaeon,' 'Callisto,' 'Jupiter and Antiope,' 'Europa,' 'Venus' (Pondo), 'Venus and Cupid' (Florence), 'Danae' and 'Venus and Adonis' painted for Philip II, 'Venus Anadyomene' (Bridgewater Gallery), the 'Madonna of the Cherries' (Vienna) and the 'Madonna of the Rabbit' or 'Madonna del Consiglio' (Louvre) prove that his 'Virgin and Child' can stand comparison with any other great master in Italian art. As a portrait painter Titian is unequaled. According to Vasari «There has scarcely been a noble of high rank, scarcely a prince or lady of great name, whose portrait has not been taken by Titian.» His list of famous men and women is long. Perhaps at the very top stands the unknown 'Man with the Glove' (Louvre), young, handsome and charming. Many times was the Duchess of Urbino painted, the most famous being the 'Bella' in the Uffizi, Florence. Many times also his daughter, Lavinia, smiles down the centuries. Sometimes she is holding a dish of fruit (Berlin), sometimes a jeweled casket (Lord Cowper) and sometimes a fan (Dresden). The Uffizi contains four superb studies: Catarina Cornaro, Queen of Cyprus, Sandovino, Francesco, Duke of Urbino and Eleanora, the Duchess of Urbino. Charles V on horseback at the battle of Muhlberg, now in the Prado, Madrid, shows for all ages what kind of man the emperor was. Titian painted three portraits of himself: one in early life (Vienna), one in middle age (Berlin) and one in old age (Prado, Madrid). Francis I (Louvre), though a great portrait, was not painted from life, for Titian never saw this sovereign. The famous work in the Louvre called 'Titian and his Mistress' represents Alphonso, Duke of Ferrara and his wife Laura di Dianti. Pope Paul III was another fine subject. The great 'Trinity' or 'Last Judgment,' in which Charles V appears, was so loved by the emperor that he had it in his room during his last illness and kept his eyes fastened on it till the last. Titian also painted one great historical work in 1539, 'The Battle of Cadore' representing the moment when the Venetian captain, facing the enemy, dashed into the rushing stream with men and horses. All are represented life size. This picture perished by fire in 1577 and is only known to-day by Fontana's engraving and a sketch by Titian in the Uffizi.

"Titian," writes Kugler, "was born in grand Alpine scenery amidst a sturdy and vigorous race; and it is in the combination of these antecedents with the gorgeous color and stately forms of Venetian life that we trace that breadth of qualities so conducive to the development of art in which he takes precedence of every other painter. Two forms of nature especially courted his pencil — landscape and portraiture; and in each he revealed to the world treasures of truth and poetry not worked out before. For Titian is not only the painter of humanity in its largest distinctions — in the beauty of woman, the dignity of man and the artlessness of childhood — but he is especially the delineator of all those under every aspect of the high born and the affluently placed classes of society. Sir Joshua Reynolds says of him whatever he touched by a kind of magic he invested with grandeur and importance. The intellectual, the noble, the splendid, the well-formed, the well-fed, the well-dressed were the mutual subjects of his art. His type accordingly of Christ, John the Baptist and the Magdalen — characters in whom the pride of life and the abnegation of self are incompatible qualities — cannot satisfy those who look for the realization of a sacred idea. Titian can, therefore, hardly rank as a painter of religious feeling except in his earliest works when he was still under the influence of Giorgione."

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Esther Singleton.

TITICACA, tē-tē-kä'kä, the largest lake in South America and one of the most remarkable on the globe, situated on the southeastern boundary of Peru, its eastern shores belonging to Bolivia. It is about 130 miles long and 30 miles wide through most of its length, though 43 miles at one point. It lies at an altitude of 12,635 feet, in a large plateau basin between the two main cordilleras of the Andes. It is of irregular shape, and contains several islands. Copacabana Peninsular almost cuts it in two at the southeast extremity. The greatest depth is 720 feet. Its surplus water is discharged southward by the river Desaguadero, which flows into Lake Aullagas, and thence disappears in the Salinas Grandes, so that the water of the lake does not reach the ocean. Lake Titicaca was formerly much larger than now, and is still decreasing in area. There are geologic evidences that it formerly discharged into the Amazon watershed, in the eastern side of the Cordillera Real. In spite of the high altitude the shores are inhabited, and steamers ply on its waters. The largest island in the lake also bears the name Titicaca. Puno is the largest town on its shores. The locality was the seat of a prehistoric civilization of great interest, and the islands and the regions around the lake contain some of the most interesting architectural remains of ancient Peru.

TITLARK, a small lark-like bird of the family *Motacillidæ*, many species of which inhabit most parts of the world in every variety of region, some being migratory, others permanent residents. The nest is made upon the ground, or dry grass and stalks, lined with finer plants and hair, and the eggs are four to six. The American titlark (*Anthus rubescens*) is six and one-half inches long and 11 in wing extent; olive brown above, each feather darkest in the middle; beneath yellowish brown, the sides of the neck spotted longitudinally with dark brown; round eyes and superciliary stripe yellowish; central tail feathers like back, the others blackish brown, the external one mostly white and a white spot at the end of the second; primaries edged with whitish, and the other quills with pale brownish; bill and feet black. It is very generally distributed over North America, extending to the Pacific and to Greenland, and is accidental in Europe. The flight is exceedingly easy and graceful; it occurs in flocks of tens or hundreds, running fast on the ground, vibrating the tail whenever it stops, not squatting like the larks, but moving the body on the upper joints of the legs. It is found in the fields, on the prairies, along rivers, and on the seashore; the notes are clear and sharp tweets, the last much prolonged; it breeds in the East only north of the Saint Lawrence River, and especially in the coastal districts of Labrador; but in the Rocky Mountain region spends the summer much farther south, but at cool elevations. This bird is very similar to the *A. obscurus* and *spinoletta* of Europe, though the latter has a longer bill and less slender tarsi and toes, and has no yellowish superciliary stripe; the outer tail feathers are not white, and the spots are less distinct below. Among the European species the most extensively distributed is the meadow titlark or pipit (*A. pratensis*), which is a favorite field-bird in Great Britain. The tree-pipit or titlark (*A. arboreus*) is another favorite. Both are kept as cage-birds. Consult general works, and Coues, 'Birds of the Northwest' (Washington 1874).

TITLE-DEED, a paper, or one of several papers, written or printed, or partly written and partly printed, describing a property in detail, and through what ownership or authority it came into the present custody, by virtue of which a person claims ownership or title. The term is often used in the plural to denote the several muniments of title turned over by the grantor on delivering the property to the grantee or his agent and in this sense title-deeds are any documents containing evidence of the title or any part of the title to real estate or other property so granted. Every owner of property is supposed to have his own title-deeds, but the modern system of registering real estate transfers requires an official copy of the title-deeds to be entered in the office of the registrar or of whatever public agent assumes the duties of registrar, and there be open to the public inspection.

TITLE INSURANCE is effected in countries having public offices for the record of titles to real estate through the agency of title guaranty companies. This business has assumed importance in the United States where the system is most fully developed. In this country law requires all transfers of real estate, all mortgages, wills, judgments, etc., to be entered in official registers open to public inspection. In the larger cities these records soon became so voluminous that the matter of verifying title became a cumbersome affair callfng for the prolonged services of expert realty lawyers. Moreover such research was attended with long delay and with great expense; yet this had to be repeated every time a fresh transfer or mortgage took place, since the vendee or mortgagee was not apt to accept the property without assurance of its being unencumbered and sound in title. Finally in 1876 a Philadelphia company was organized to guarantee titles, and the plan proved so successful that companies have since been organized in nearly every large city in the country. The plan of operation of these companies calls for large capital, for in order to be independent of the clumsy and sometimes inaccurate methods of public record offices the title insurance companies form their own records of real estate titles in the locality in which they operate, and must maintain for this purpose a large staff of expert title examiners. On account of the size of its force a well-equipped company can make the first examination and guaranty of a title in less than a week, whereas from one to three months was sometimes required by the practising attorneys. The fee required in this first instance is usually about the same as that charged by a reliable lawyer, or, in case of a long examination, about one-half per cent of the value of the property negotiated; but it has the added advantage of guaranteeing against loss if there is any inaccuracy of the search. After a property has been once examined and its title guaranteed, the noting of future transactions affecting it is a simple matter, and subsequent guaranties are issued upon short notice and for a small fee.

TITLE TO PROPERTY. See REALTY.

TITLE REGISTRATION, a system of public records under which titles to real property are recorded in public offices for the purpose of expediting the process of transfer and of giving legal notice to claims of ownership to lands so entered. In England the registration of titles is of comparatively recent introduction, the system being due to the land transfer acts of 1875, under which it was first successfully practised. The office of record in that country is conducted by a registrar appointed by the lord chancellor, who also fixes the fees for the various services of the office. These fees, paid in the form of stamps, provide the emoluments of office from which the registrar draws his pay. Under the act of 1875 the registrar must approve of the title submitted and in case of a sale the vendor must make affidavit that he has produced all the deeds, wills and other instruments of title as well as all the evidences of encumbrances on the land, in order that the registrar can make a fair entry. When once a title is registered no adverse title will acquire any advantage by length of possession, but any person claiming an adverse interest can lodge a caution of that fact and be entitled to notice of all further transactions on the property. When the registered land is sold the name of the transferee is entered on the register and he is issued a certificate of title. The law is not compulsory in England, but is being gradually adopted because of its advantages over the old system.

In the United States it early became customary to register titles, mortgages and notices of transfer of interest, encumbrances, etc., in public offices, usually in the office of the county clerk of the court. This officer has no judicial or discretionary powers and is empowered only to register official copies of deeds, mortgages, agreements, etc. In place of the issuance of a certificate the clerk notes on the original or a duplicate deed that a true copy has been entered on the official register and this copy becomes legal notice of claim of title to all the world. The clerk of the court, who is a county officer in the United States, and elected, not appointed, frequently delegates this part of his work to an appointed assistant known as the registrar of deeds. Between the parties of a conveyance the recording or non-recording of the instrument is of no moment, but conveyances made after the first is recorded are void, and any conveyance not recorded is void as against a subsequent conveyance to a bona fide purchase from the person in whose favor a recorded conveyance has been executed. State regulations, however, usually govern the matter of registration in regard to its effect as constructive notice. For the «Australian system» of national land registration, see TORRENS SYSTEM.

TITLES, words or phrases bestowed on individuals as a mark of distinction, rank or dignity, and in some cases implying office or vocation. Titles may be official, honorary, civil, military, temporal or ecclesiastical. The use of titles is as old as civilization and seems to have arisen from titles bestowed for some public service, and only later to have been bestowed in virtue of the dignity of the office or employment of the recipient, and even later to have become hereditary. As used by the Greeks and Romans, however, titles conformed to the first and the last customs — they were bestowed for service and were hereditary. Later, Roman offices carried their titles with them irrespctive of the merits of the holders, for example, the names Cæsar and Augustus, and the phrase *pater patriæ*, all of which came to be applied to the imperial throne regardless of the character of the occupant.

Titles to-day in existence in Europe are interesting relics of the feudal period. First came the titles of count and duke. Counts (*comites*, companions) were the followers of the feudal lords and the dukes (*dux*, leader), the military leaders.

Placed at the head of provinces, their rôles were the same, to administer their territory, defend it against depredations and forays from without, and to organize and lead its man-power in the military service of the overlord when the latter went forth to battle. Later came the appellation marquis to denote those in charge of the «marches,» marshes, usually on the frontiers or border lands. Under the count came his lieutenants with the title of viscounts. As regards the title baron, which signifies man *par excellence*, it was at first applied only to the higher feudal personages, the great tenants-in-chief of the Crown. The knight was he who had received an order of chivalry or knighthood, and so on through the several grades of feudal society.

Among modern rulers the titles king and emperor with the feminines and in the case of the late Russian Empire that of tsar, are the titles of supreme heads of government. The title king harks back to a period when its bearer bore it by right of *kinship* as the head of his tribe. The later *rex* and its derivatives in the Romance languages denotes a ruler. And the word emperor, which is used in the same sense, originally denoted the ruler of an empire or a confederation of several states, each of which had a king at its head. In this respect the word was advisedly applied to William II, late emperor of Germany. Meanwhile it had become customary to add to the titles signifying the office, honorary qualifying titles. Henry IV of England was called «Grace»; Edward IV, «Most High and Mighty Prince»; Henry VII, «Highness»; and Henry VIII, «Majesty.» This latter title was universally adopted by the sovereigns of Europe, and was subsequently subjected to further qualification, as in the case of James I, who was called «His Sacred Majesty of England,» and was formally addressed as «James, by the Grace of God, King of Great Britain, France and Ireland, Defender of the Faith,» etc. Catholic rulers, meanwhile, had assumed such titles as «Catholic» for Spain, «Most Faithful» for Portugal, etc. The present ruler of Great Britain receives the title, «George V, by the Grace of God, of the United Kingdom of Great Britain and Ireland and of the British Dominions beyond the Seas King, Defender of the Faith, Emperor of India,» etc. The eldest son of the British sovereign is styled the Prince of Wales, and the eldest daughter the Princess Royal; the other sons and daughters are styled prince and princess, and all, together with the children of the sons of the reigning sovereign, are addressed as Royal Highness. The five orders of nobility in Britain are distinguished by the titles of honor — duke marquis, earl, viscount and baron. These nobles have several titles, granted by district patents, in their progressive steps in the peerage. A duke may thus be a marquis, an earl, a viscount, and a baron. One of the inferior titles is permitted as a matter of social dignity to be assumed by the eldest son. Thus the eldest son of the Duke of Sutherland takes the courtesy title, as it is called, of Marquis of Stafford. Courtesy titles do not raise their bearers above the rank of commoners, and consequently the eldest sons of peers are eligible for election as members of the House of Commons. The lowest hereditary title is that of baronet, which, besides its name, which is placed after the name and surname of its bearer, entitles him to the prefix Sir. The dignity of knighthood is not hereditary. The titles of esquire and master (Mr.) are now given indiscriminately to nearly all classes of persons. The Continental titles of prince, duke, marquis, count, viscount and baron often differ considerably from the corresponding titles in England. Thus in England the title prince is confined to members of the royal family; Austria has, or had, archdukes but no dukes, Russia had only grand dukes.

It is an axiom that hereditary titles lose their value in proportion as they become common. In England this latter danger is obviated by the rule of primogeniture which insures that there shall be but one bearer of a title in a generation, while in France all the sons receive titles, the eldest the highest title, for instance, that of duke, the second son, a marquisate, and so on. In Mohammedan lands the only hereditary title is that of sherif, except in the ruling houses. Pasha and bey, at first purely military titles, are now conferred on civilians, but are not hereditary. Japan had a system of titles closely resembling that of Europe, and like the latter, based on her old feudal system. China, under the empire, ennobled the ancestors of the person to be honored and usually made the title hereditary for a stated number of generations. The Turkish sultan is style *padishah* (lord king) and as head of Islam he is «the Commander of the Faithful.» The ruling houses of India have a graduated system of titles closely akin to that of Europe. The Pope of Rome is distinguished by the title «His Holiness,» and addressed as «Your Holiness»; cardinals by the title «His Eminence»; bishops as «Monsignor,» and in England as «My Lord.» The title of bishops is «The Lord Bishop of ——,» of archbishops «The Most Reverend the Lord Archbishop of ——,» deans are addressed as «Very Reverend,» and archdeacons as «Venerable.» All clergymen and ministers of the Christian and Jewish faiths are now generally styled «Reverend.»

Titles in the United States.— Hereditary titles and other titles of nobility are forbidden by the Federal Constitution and the citizen of another country who bears such a title when he becomes a citizen of the United States must relinquish his title. Various offices of dignity and trust carry with them certain forms of address, but these forms of address pertain to the offices alone, and the holders of these offices have no claims to the prescribed form of address after their terms of service have expired. The President, governors of States, and ministers of foreign nations are addressed, and spoken of, as your or his «Excellency,» save in the case of speaking to the President, who should be addressed as «Mr. President.» The vice-president, members of the Cabinet and members of Congress, heads of departments, assistant secretaries, comptrollers and auditors of the treasury, clerks of the Senate and House of Representatives, State senators, law judges, mayors of cities, etc., are entitled «Honorable.» Military, naval, ecclesiastical and other professional dignities are distinguished by the titles common to the English-speaking peoples of the world. Consult the 'Almanach de Gotha'; 'Burke's Peerage'; Cokayne, G. E., 'Complete Peerage' (new ed., 1910); Phillips, Walter Alison, 'Titles of Honor' (in 'Encyclopedia Britannica,' Vol. XXVI, Cambridge 1911).

TITLES OF HONOR. See ORDERS (ROYAL) AND DECORATIONS; TITLES.

TITMARSH, M. A., or Michael Angelo, a pseudonym employed by Thackeray when contributing his 'Paris Sketch Book,' 'Yellowplush Papers,' etc., to *Fraser's Magazine.*

TITMOUSE, one of the diminutive birds of the subfamily *Parinæ,* family *Paridæ,* which are among the most interesting of passerine birds. There are more than 75 known species, ranging widely over most parts of the world except Australia, but most abundant in the temperate and colder regions of the northern hemisphere. None of them are really migratory, though they roam widely during the winter in search of food, nor are they gregarious, though in this particular also stress of weather frequently causes them to gather in flocks, often with other small birds,—as redpolls, finches, etc. They are not songsters, though most of them have characteristic, and frequently musical, call notes, and during the breeding season they sing after a fashion, rather weakly. They are very active, restless, familiar birds, usually showing little fear of man and oftentimes coming about houses in their continual search for food. They eat everything from seeds to the eggs and young of other birds. The nesting habits are varied, but they lay numerous eggs and raise two or more broods each season. The plumage is never brilliant, though occasionally striking, but is most frequently plain, though very tasteful.

Structurally the titmice, aside from their small size, are hard to distinguish from the jays. to which birds their habits also ally them in many ways. The bill is short and stout, straight and unnotched, and there are no rictal bristles, but the base is covered by tufts of bristly feathers, directed forward, entirely concealing the nostrils. The feet are stout, with scutellate tarsi and short toes. The wing is rounded, with 10 primaries, of which the first is exceedingly short. The tail as long as or longer than the wing is composed of 12 feathers, and usually rounded or graduated. The plumage of the body, long, soft and loose.

Of the 75 species of titmice, one-fifth occur in America all of these having been taken within the limits of the United States. About two-thirds of all the species belong in the genus *Parus,* and the same proportion holds among our American forms. The most abundant and familiar of our species is the black-capped titmouse (*P. atricapillus*), widely distributed and known everywhere as the chickadee. The typical form ranges in eastern America from typical form ranges in eastern, but closely allied sub-species, or species, occupy practically all the rest of the Continent. The general color is ashy-gray, the back with a brownish tinge, the under parts white, or nearly so; the crown, nape, chin and throat black, with the cheeks white. In size, the various forms range from four and one-half to five and one-half inches, of which the tail is about half. The chickadee is a very active, tireless little bird, retiring to the woods and swamps during the summer, but in winter very abundant in our villages and parks and about houses. It can easily be attracted to any spot where food is provided, and if unmolested by cats or otherwise will soon become very familiar. Although it eats bread and crumbs and other articles of a vegetarian's diet, its tastes are carnivorous and it is especially fond of «meat-on-the-bone.» When foraging for themselves, chickadees eat an enormous number of insects and thus justify their existence, if that were necessary. As a matter of fact chickadees are so familiar, so daintily clothed, so cheerful even in the severest weather, and so courageous, and their usual call note «chick-a-dee-dee,» is so pleasing, none of our birds is more universally loved and enjoyed. In the spring, when the mating begins, the chickadee has another note, a plaintive, though not drawled, «pe-we.» The nest is a mass of moss, feathers, wool, plant down, etc., placed in a hole in a stump, tree or fence post, usually not far from the ground. The eggs are five to eight in number in each of the two broods, and are white, spotted with reddish-brown. The chickadee of the South Atlantic States (*P. carolinensis*) is said to have notes quite different from the northern species. In the southeastern United States, ranging north to New Jersey, but rarely further, is another very abundant titmouse, quite different from the chickadee in both color and form, known as the tufted titmouse (*Parus bicolor*). It is a gray bird, with a black forehead, and a conspicuous crest, an inch longer than the chickadee and not so attractive. The notes are not so attractive as those of the chickadee and become monotonous; the most common rendering in words is «peto, peto, peto,» but it also has other calls. The tufted titmouse is not so familiar or confiding as the chickadee and is distinctly a woodland bird, seldom seen about houses. It is not shy and is readily approached, while the prominent crest makes it easy to recognize. The nesting habits and the eggs are similar to those of the chickadee, but the latter are considerably larger. A tufted titmouse occurring in the valley of the Rio

Grande (*Parus atricristatus*) is notable for its glossy black crest, while the bridled titmouse (*P. wollueberi*) is a related species occurring in the southwestern United States, and is remarkable for the very conspicuous black and white markings on the head. Besides several other interesting species of *Parus,* the southwestern United States is the home of four or five very small titmice, belonging to the genera *Psaltriparus* and *Auriparus.* The former are called «bush-tits» and though very plainly colored with black, brown and plumbeous, their very small size, four inches or even less, and their large, woven, pensile nests, with lateral entrance, make them an interesting group. The gold tit (*Auriparus flaviceps*) is of about the same size, but is notable for the rich yellow head, the other upper parts being ashy and lower parts whitish. These little birds build great globular nests of twigs, in the bushes, lining them with down and feathers. The eggs are pale bluish speckled with brown.

Of the tits of the Old World, seven species occur in Great Britain, but one of them, the crested tit (*Parus cristatus*), is only an accidental visitor. The great tit (*P. major*) is the largest European species, though only about the size of our tufted titmouse. The general color is yellowish and gray, with white cheeks and black head and throat. The blue tit (*P. cœruleus*) and the cole tit (*P. ater*) are the commonest of the English species. The former has the top of the head light blue and a bluish cast to the rest of the plumage. It is the species usually called «tom-tit.» The azure tit (*P. cyanus*) of Siberia, which is sky-blue and white, and the large Japanese tit (*P. varius*), which is handsomely marked with chestnut, will serve as examples of the more brightly colored titmice. The long-tailed tits of the genus *Ægithalos* are remarkable not merely for their excessively long tails but because they build very elaborate cozy nests, which are purse-shaped and hang free or are attached along one side to the trunk of a tree. The eggs are very numerous, as many as 20 having been found in one nest.

Consult in addition to standard ornithologies, Coues, 'Birds of the Northwest' (Washington 1874); and 'Birds of the Colorado Valley' (Washington 1887), and Evans, A. H., 'Birds' (in 'Cambridge Natural History,' Vol. IX, New York 1900).

TITTLEBAT TITMOUSE, the name of a London shop clerk who figures as the hero of «Ten Thousand a Year,» a novel by Samuel Warren (q.v.).

TITULAR BISHOP, an episcopal title in the Roman Catholic Church substituted by Pope Leo XIII for the older one of bishop *in partibus infidelium.*

TITULAR CHURCH, a name given to the parish churches of Rome, as distinct from the patriarchal churches, which belong to the Pope, and from the oratories. Each titular church is under a cardinal priest, has a district assigned to it, and a font for baptism in case of necessity.

TITUS, companion and well-loved friend of Saint Paul. He was converted by the apostle (Tit. i, 4), at Antioch 50 or 51 A.D., and in the same year accompanied him to Jerusalem, and was present at that first council which recognized Gentile converts as part of the Church, and exempted them from the burden of the Mosaic ritual (cf. Acts xv, 1 — 35 with Gal. ii, 1-3). Paul soon afterward carried out the liberty thus accorded by refusing to require Titus, a Greek, to be circumcised (Gal. ii, 3-5). Titus was subsequently with Paul at Ephesus (56), whence the former was sent on a special mission to the Corinthians, carrying with him Paul's second epistle to that church (2 Cor. viii, 6, 22, 23; xii, 18). When Titus returned (57 A.D.) he found the apostle in Macedonia (2 Cor. vii, 5-6, 13-15). Subsequently (65 or 66 A.D.) he was left in Crete to arrange the affairs of the Church and «ordain elders in every city» (Tit. i, 5). Returning thence to Rome he was dispatched by Paul (66 or 67) to Dalmatia (2 Tim. iv, 10). Titus returned to his work in Crete, and died at an advanced age. See also TITUS, EPISTLE TO.

TITUS, Flavius Sabinus Vespasianus, Roman emperor: b. 40 A.D.; d. Reate, 13 Sept. 81 A.D. He was the son of Vespasian, whom he succeeded as emperor in 79 A.D., and was brought up at the court of Nero with his friend Britannicus, whom he accompanied in his wars in Germany and Britain. Later he commanded a legion in the war of Vespasian against the Jews, conducting the campaign in Judæa in 69 in the place of his father, who was then called to the imperial throne. At the end of a long and cruel siege Jerusalem was taken by Titus 8 Sept. 70. Titus returned to Rome in 71, where he was rewarded with the title of Cæsar and given a part in the government of the empire. He early manifested the qualities of a humane and able ruler and he became the idol of the Roman people. The Colosseum, begun by Vespasian, was completed under his direction, and the public baths named in his honor, and other institutions for the public benefit were established by him

TITUS, Epistle to, one of the epistles of Saint Paul, stated to have been written to Titus, as bishop over the Cretans, from Nicopolis in Macedonia. It is known as one of the «Pastoral Epistles,» because devoted chiefly to admonitions on the subject of pastoral duties. In this epistle Saint Paul describes what a bishop ought to be, and applies severe language to certain of the Cretans. This, and the two epistles to Timothy, have been subjected to much discussion. See TIMOTHY AND TITUS, EPISTLES TO.

TITUS ANDRONICUS. Several plays of the Shakespeare canon preserve a mystery due to almost total absence of external evidence; in the case of 'Andronicus' the tantalizing uncertainty arises from the existence of an unusually large mass of data. Shakespeare's substantial concern in the tragedy is avouched by the double testimony of Meres, who in 1598 lists 'Titus Andronicus' among Shakespeare's tragedies, and of Hemmings and Condell, who in 1623 included the play in the Shakespeare Folio. On the other hand, three quarto editions are anonymous, and though this is natural enough in the case of the first (1594), it is surprising that the publishers of the 1600 and 1611 quartos should not have mentioned Shakespeare's then popular name. Moreover, a large majority of the best critics have been strong in their conviction that the marks of Shakespeare's mind are not evident in the plot, the characterization, or the language of this play. There is little of the unevenness here which one finds in works written by inferior authors and revised by Shakespeare; in versification as in dramatic power this tragedy is pretty consistent throughout, and it bears much more affinity to the work of Kyd or Peele than to Shakespeare's. The problem is complicated by references to what may conceivably have been earlier versions of our play. A drama called 'Titus and Vespacia' (Vespasian?) was acted for the first time, 11 April 1592. We cannot positively determine whether this was an old form of 'Titus Andronicus' or, as the title more naturally suggests, a quite unrelated work on the subject of two historical Roman emperors. Another work, called by Henslowe 'Titus and Andronicus' or 'Andronicus,' was put on the stage as a new work in January 1594, by the Earl of Sussex's company and revived in June of the same year by the Lord Admiral's and Lord Chamberlain's (the last Shakespeare's company). On 6 Feb. 1594, 'A Noble Roman History of Titus Andronicus' was licensed to John Danter, and in the same year our play, called 'The Most Lamentable Roman Tragedy of Titus Andronicus,' was printed by Danter for Edward White and Thomas Millington. The subsequent quarto editions in 1600 and 1611 were printed for White, and all three were sold at the same shop. Without entering into fuller discussion of this evidence and of other entries in the Stationers' Register, it may be said that the records seem to establish the identity of Henslowe's 'Titus and Andronicus' with our play as printed in 1594. (The contrary conclusions of Prof. G. P. Baker, *Publications of Modern Language Association* 66–76, 1901, have been invalidated by the discovery in 1905 of the 1594 quarto). If we eliminate Henslowe's earlier 'Titus and Vespacia' as probably unrelated, there seems little reason to believe that any version of 'Titus Andronicus' existed in Shakespeare's lifetime which differed essentially from that we possess. Danter licensed 'Titus Andronicus' for publication (6 Feb. 1594) on the same day on which Sussex's company is last recorded as acting it, and his manuscript, printed later in the year, would seem to be that which they acted. We have no reason to believe that Shakespeare revised any plays either for this company or for Pembroke's company, which is said also to have performed the piece. The text of the play in the Shakespeare Folio of 1623 must, on the other hand, be that acted by the Lord Chamberlain's company in June, 1594, or later. Since the differences between these versions, however, are relatively quite unimportant (Act III, sc. ii is added in the Folio), it appears as likely on bibliographical as on stylistic grounds that Shakespeare had no more than a slight part in the play.

No direct source for 'Titus Andronicus' has been discovered. Its relation to two later continental works, 'Aran en Titus' (Aaron and Titus) by the Dutch poet Jan Vos (printed 1641) and a German play of Titus Andronicus and the arrogant empress (ca. 1620), has been learnedly discussed by H. De W. Fuller (*Publications Modern Language Association* 1–65, 1901); but it seems probable that these foreign works, as well as another German play of which traces exist, are based upon perversions of the extant 'Titus Andronicus' text, as disseminated by traveling English actors, and not, as Fuller argues, upon two hypothetical earlier English plays. Early 17th century allusions to 'Titus Andronicus,' though not very numerous, are such as to prove that the play was popular with the masses of the public. Later, John Downes, writing of the performances of Sir William Davenant's company after the Restoration, mentions 'Titus Andronicus' among several others which "being old plays, were acted but now and then; yet being well performed were very satisfactory to the town." In 1687 Edward Ravenscroft published an adaptation 'Titus Andronicus, or the Rape of Lavinia. Acted at the Theatre Royal,' with a preface containing some important remarks concerning the old play. Among the more unconventional modern theories regarding the authorship of 'Titus Andronicus' may be noted Grosart's argument that it was written by Greene, 'Englische Studien' (1896); J. M. Robertson's that it is essentially Peele's 'Did Shakespeare write Titus Andronicus' (1905), and an ill-considered recent hypothesis of H. D. Gray that the play was originally by Shakespeare, revised by Greene and Peele, 'Flügel Memorial Volume' (1916).

TUCKER BROOKE.

TITUSVILLE, Pa., city in Crawford County, on Oil Creek and on the Pennsylvania and the New York Central railroads, 100 miles north of Pittsburgh and 50 miles southeast of Erie, Pa. The city is on a plain which slopes slightly toward the south and east. The natural drainage is supplemented by an excellent system of sewerage. The water is obtained from artesian wells. The broad streets are largely paved and tree-lined. Electric trolley lines traverse the principal streets. The manufacturing industries consist of one of the largest iron works in the country, a high grade steel works, machine shops and foundries, large oil refineries, paraffine works, large branch of the American radiator works, large branch of the Bethlehem Steel Company, chemical works, planing mills, specialty works, cutlery works and an electric light and power plant. The output consists of iron, car tanks, steam engines and boilers, forgings, oil well machinery and fittings, gasoline engines, refined oils, gasoline, etc. There are large oil fields in the vicinity and the first well sunk for petroleum was drilled just outside of the city limits in the summer of 1859, striking oil on 27 August of that year. There are three banks consisting of a national bank, a commercial bank and a trust company. One of the finest banking buildings in the State was erected in 1918. Among other public buildings are 12 large edifices and two halls for religious services, a high school with a four-year course, four graded public schools and a kindergarten, all under one superintendent; Saint Joseph's Academy, kindergarten and parish school. The city has also an excellent library, "Benson Memorial Library," an excellent Young Men's Christian Association and Young Women's Christian Association and the Titusville Hospital. Titusville was first settled in 1796, becoming a borough in 1847 and chartered as a city in 1866. The town was laid out in streets in 1809. It suffered great damage from flood and fire 5 June 1892 which destroyed one-third of the city with a loss of 60 lives. The city owns and operates the waterworks and one of the electric light plants. The government is vested in the mayor and five commissioners, the mayor being elected for four years and the commissioners for two years. The majority of the people are native born, the predominating foreign element consisting of Scandinavians, Irish and Germans. Pop. 8,550.

TIUI, tē-wĕ', or **TIVI,** tē'vē, Philippines, pueblo, province of Albay: on Lagano Bay, on the northeast coast, 23 miles north by west from the pueblo of Albay. It is the centre of a hemp growing region, and exports hemp by way of Tabaco. It is especially celebrated for its thermal springs of iron and sulphur waters with medicinal properties, which are visited by large numbers of natives. Pop, about 11,000.

TIUMEÑ, tyoo-mĕny', Russia, in Siberia, government of Tobolsk, 120 miles southwest of Tobolsk, on the Tura River. It is an important centre of trade, lying on several commercial routes, with railroad communication. It has a large technical school. Its principal manufactures are leather, soap, candles, carpets, pottery and woolen goods. These articles are exported to China, the Kirghiz steppe, Bokhara and everywhere in Siberia. The Tiumeñ and woven carpets are especially renowned. In Tieumeñ was located a famous exile prison. Pop. about 35,000.

TIVERTON, R. I., town in Newport County, on Narragansett Bay, near Fall River, Mass., and on the New York, New Haven and Hartford Railroad. There are cotton manufactories and oyster and fishing industries. Pop. 4,032.

TIVOLI, tē'vō-lē, Italy, in the province and district of Rome, on the Teverone or Aniene, 16 miles northeast of the capital. Its position on a rocky height overlooking the river is extremely picturesque. Tivoli commands a fine view of Rome and the Campagna. It contains a fine modern cathedral which contrasts sadly with the other town buildings. Its antiquities are numerous and interesting, and include a temple of the Tiburtine sybil, temple of Vesta, villa of Hadrian, etc. The artificial cascades formed by the Teverone constitute an interesting feature of the landscape and supply power for the electric lighting of Rome, and for various factories. The old Latin name was Tibur, important in the Latin Confederation. It became subject to Rome in 338 B.C. The population of the commune is about 15,000. Consult Baedecker's ‹Central Italy and Rome.›

TLAPALLAN, the mythical home of the Toltecs, and the land from which came their great culture god, Quetzalcoatl, and to which he returned when his mission on earth was done. See QUETZALCOATL; MEXICO — MYTHOLOGY; CHOLULA.

TLAXCALA, tläs-kä'lä, or **TLASCALA,** Mexico, the smallest state in the republic, situated between the states of Puebla, Hidalgo and Mexico. Area, 1,534 square miles. The capital, Tlaxcala, located about 60 miles east of Mexico City, was in ancient time a large city, but its 1919 population is only 2,800. It has a bishop's palace and a statehouse that retains much of their former grandeur. The holy well of Ocotlan, in the suburbs, is covered by a costly and imposing sanctuary. The state lies within the plateau region, and its surface is broken by high mountains. The principal occupations are agriculture and some manufacture of cloth, though iron and silver are found in the mountains. Tlaxcala was at the time of the Discovery, a powerful native state which had maintained its independence of the Aztecs. It became an ally of Cortes and retained its own government for a time under the Spaniards. Pop. about 192,000, almost all Indians.

TLEMCÉN, tlĕm-sĕn', Algeria, in the province of Oran, 70 miles southwest of the city of Oran, and 30 miles from the Mediterranean. It is a walled town with nine gates, and is divided into three sections, namely, the citadel and military establishment; the business portion, containing the residences of foreigners; and the native section. The town stands on a mountain slope at an elevation of 2,500 feet, amid olive-groves and vineyards. It has 32 mosques, Protestant and Catholic churches, a museum and Jewish synagogue. The manufactures comprise textiles, carpets and leather articles, burnooses, etc. Trade is important, especially with Morocco. It is a historic city, some of the mosques dating from the 11th century. At the height of its prosperity, in the 13th and 14th centuries, it is reputed to have had 125,000 population. Pop. 39,874.

TLINKET, or **TLINKIT,** a group of tribes which constitute a distinct linguistic stock known as Kolushan. They inhabit the coast and islands of southern Alaska. Previous to the advent of the white men their houses were rudely constructed, and their trade carried on with neighboring tribes. The exchange of slaves was carried on extensively, and they were treated by their masters with the greatest cruelty. They have greatly diminished of late years, till there now remain but about 5,000, a large number of them being employed in the canning industry.

TO A SKYLARK. Shelley's ‹Skylark,› perhaps the most famous of English lyrics, was written at Leghorn, Italy, and published with ‹Prometheus Unbound› in 1820. It is composed of 21 five-line stanzas, each of which ends with a long line that represents the brief pause of the bird on the wing as it prepares for yet higher flight. Mrs. Shelley says: «In the spring we spent a week or two at Leghorn, borrowing the house of some friends who were absent on a journey to England. It was on a beautiful summer evening while wandering among the lanes, whose myrtle hedges were the bowers of the fireflies, that we heard the carolling of the skylark, which inspired one of the most beautiful of his poems.» This exquisite lyric has been used in generations of school «readers» and «selections,» but even such familiar handling has not served to tarnish the peculiar qualities in which it still remains matchless and unapproachable. Shelley's skylark, unlike Wordsworth's, loses itself in the empyrean; it is a spirit not a bird, an embodied voice, an aspiration. It is beside the mark to urge that the poem has «the defects of its qualities»; for, from the standpoint of what the poet meant to do, it has no defects. It is a perfect work of art, having a worthy purpose which it perfectly attains. The poem pursues the flight and the song of the bird swiftly up to the blue; four exquisite similes liken the lark to the poet, to the maiden, to the glow-worm and to the rose; the song of the bird sings itself in the heart of the poet; at the end comes the pathos of the infinite and unsatisfied desire never absent from Shelley's nature lyrics. The criticism of almost a century has applied to the 'Skylark' the epithets which have long since become banal but which seem inevitable: it is melodious, exquisite, ethereal, ecstatic. As such it is unsurpassed and is probably unsurpassable. Wordsworth's 'Skylark' represents a more human point of view; Keats' 'Ode to a Nightingale,' an equally consummate achievement of a different kind.

MARION TUCKER.

TOAD, an amphibian of the anourous family *Bufonidæ* or some related family in the series *Arcifera*, in allusion to the structure of the shoulder girdle. The *Bufonidæ* present the following distinctive features: The tongue is well developed, fixed to the front of the mouth, and has the hind end free. The result of this arrangement is that it can be filliped by means of appropriate muscles with the greatest speed and precision, and thus serves these usually totally toothless animals in the capture of insects which adhere to this mucous-coated organ. Teeth are always absent from the jaws, but may be present on the vomer in a few foreign genera. The hind toes are more or less webbed, the front toes webless and the ends of the toes are neither clawed nor furnished with adhesive discs. In all cases the vertebræ are procœlous or have their bodies hollowed in front, the transverse processes of the sacrum are expanded and ribs are absent. This family is an extensive one of about 15 genera and 100 species and is cosmopolitan, but is especially well represented in tropical America. The species differ considerably in habits, most of them being terrestrial burrowers, but some are aquatic, others arboreal.

Within the United States, *Bufo* is the only genus, being represented by 9 or 10 species, most of which belong to the southwestern United States and Mexico. The common eastern toad (*B. lentiginosus*) is found in one or other of its sub-species throughout the eastern United States and Canada. The familiar roughness and wartiness of the skin of toads is due to the presence of glands and, especially on the head, to bony deposits. They are chiefly terrestrial and nocturnal, and feed upon insects of which they destroy large numbers. Toads visit the water in March or April, their breeding season, for the purpose of depositing their eggs, which are in long strings and are fertilized by the male upon their extrusion. During the mating season the males are very noisy at night and so pugnacious that they sometimes kill one another in their encounters. Development takes place rapidly and the tadpole-stage is passed in three or four months, when the young toads leave the water in multitudes. The popular repugnance to these perfectly harmless animals has no doubt arisen from their unprepossessing aspect and outward appearance. No venom or poison apparatus of any kind exists in these creatures; and save that the secretions of the skin may be of acrid or irritant nature when brought in contact with cut or exposed surfaces, they are utterly harmless to man. There is a swelling above the eyes covered with pores and large, thick and prominent enlargements behind the eyes which secrete an acrid fluid, which protects these animals from the attack of carnivorous mammals. They also swell up with air when attacked by snakes. When handled, toads frequently eject urine from the vent, but the widespread belief that the contact of this fluid with the skin produces warts is utterly unfounded. Toads are extremely tenacious of life and can exist a long time without food; their hibernation in mud, cracks and holes has probably given rise to the stories of their being found in places where they must have existed for centuries without food and air. These stories, however, have no foundation in fact, for Dr. Buckland proved, by direct experiment, that no toad can live for two years if deprived of food and air. Another common belief that toads are often rained down is probably to be explained by the fact that great numbers of young toads frequently leave, during showers of rain, the vicinity of pools in which their larval life was spent. Toads are really extremely interesting animals, and much entertainment can be derived from their observation.

Among foreign toads are the great *Bufo agua*, large enough to fill a quart measure, of the West Indies and South America; the green toad (*B. viridis*) of Europe, noted for its change of color; the long-tongued toad (*Rhinophrynus dorsalis*) of Mexico, which feeds on termites; the European fire-toad (*Bombinator igneus*), so called from its brilliant red under parts and belonging to the family *Discoglossidæ;* and the remarkable Surinam toads, which are tongueless and carry the young in little cavities on the back. The last belongs to the distinct family *Pipidæ*. The spade-foot toad (q.v.) and the tree-toads or tree-frogs (q.v.) belong respectively to the families *Scaphiopidæ* and *Hylidæ*. Many of the toads have remarkable and interesting breeding habits, for accounts of which reference must be made to works of herpetology. Consult Boulanger, E. G., 'Reptiles and Batrachians' (New York 1914); Cope, E. D., 'Batrachia of North America' (Washington 1889); Boulenger, G. A., 'Tailless Betrachia' (London 1892); Dickerson, M. C., 'The Frog Book' (New York 1914); Gadow, 'Amphibia and Reptiles' (New York and London 1901); Kirkland, 'Habits, Food and Economic Value of the American Toad' (in Bull. 6, Hatch Exper. Sta., Amherst, Mass., 1897); Sampson, 'American Naturalist' (1900).

TOAD-FLAX, a common roadside weed (*Linaria linaria*) belonging to the family *Scrophulariaceæ*. It somewhat resembles a snap-dragon, but is smooth and has many linear leaves, either alternate or opposite and verticillate on the lower portions of the stem, and very pale green. The stem is prolonged by a terminal bracted densely flowered raceme. The blossoms are pale yellow with a short spur, a two-lipped corolla, the lower lip spreading and three-lobed, with a base so enlarged as nearly to close the throat with an orange-colored palate. This combination of orange and yellow has given rise to the name «butter-and-eggs.» It is also called ramstead. The plant has been naturalized from Europe and is rather pretty, but it is very tenacious and very difficult to eradicate.

A native toad-flax is *L. canadensis*, a slender plant, with blue flowers and with a tendency toward oppositeness. The Kenilworth ivy (*Cymbalaria cymbalaria*) is also called ivy-leafed toad-flax and is a glabrous trailing perennial, with reniform-orbicular leaves and bluish flowers. *L. triornithophora*, a European plant, is peculiar for its purple, long-spurred flowers blooming in whorls of three and resembling birds, which has suggested the Latin name, «three-birds» toad-flax. The American bastard toad-flax (*Comandra umbellata*) is a delicate, pale green, smooth plant of the sandal-wood family, with greenish white or purplish, campanulate corollas and oblong leaves quite unlike the *Linaria*. In England *Thesium linophyllum*, with leaves like those of toad-flax, is known by the same name as *Comandra*.

TOADFISH, any fish of the genus *Batrachus*, so called from the large head, wide gape and generally toad-like appearance. The common toad-fish (*B. tau*) is from eight inches to a foot long, light brown marbled with black. There are about 12 species, dwelling principally in tropical and sub-tropical seas.

TOADSTONE, (1) *in geology*, an old English name for certain amygdaloidal basaltic rocks occurring in Cumberland, England. The name is also applied to a mottled, apparently spherulitic felsite, found near Boston. (2) Fragments of rocks or precious stones, resembling toads either in color or form, also fossils of various kinds, supposed to possess special therapeutic virtues. Such objects were for many centuries highly prized in Europe, being worn as rings or amulets.

TOADSTOOLS, properly fungi of the family *Agaricaceæ*, which includes the edible mushrooms. See FUNGI.

TOASPERN, Otto, American artist: b. Brooklyn, N. Y., 26 March 1863. He was graduated at the Royal Academy of Fine Arts, Munich (1888); was the pupil of N. Gysis and P. Nauen; and became an instructor in the National Academy of Design, New York. He is best known as an illustrator of *Life; Ladies' Home Journal; Century; Harper's* and several leading European periodicals.

TOAST, originally bread dried or scorched before the fire. In the 16th century it became the fashion in England to add toasted bread to drinks. From this habit the term toast came to be applied to a drink of honor proposed to some person or sentiment during the course or at the conclusion of a meal. The growth of social drinking in the 17th century greatly increased the custom of toasting, and it became common to toast not only the reigning monarchs, the hosts and the flag, but each person of the assembled company, absent friends and numerous sentiments. Finally the term came to denote not only the drink but the person or sentiment toasted, and in this dual sense the word is used to-day. Toasts are properly drunk standing, and it is the modern custom to have some person present reply to the sentiment proposed in an appropriate speech. Consult Chamber's 'Book of Days' and Valpy's 'History of Toasting' (1881).

TOBACCO, the common name applied (1) to plants of the genus Nicotiana, of which there are a large number of species, and (2) to the dried leaves of these plants prepared in various ways for smoking, chewing or snuffing. Originating in America, the use of tobacco has been extended into practically all parts of the world and, indeed, it has come to be incomparably the most generally used of all narcotics. It appears that the name tobacco was derived from the word *tabaco*, originally employed by the natives of Haiti to designate the tube used by them in smoking or taking snuff and adopted by the Spaniards as the name of the product most generally used in smoking; although other products than true tobacco were taken by the natives in the form of snuff. The habit-forming properties or narcotic effects of tobacco are due to its content of nicotine and related alkaloids.

The tobacco plant belongs to the family of Solanaceæ and is thus related to the tomato, potato, eggplant, red pepper and jimson weed. There are some 50 or more species of Nicotiana but only two of these, *N. tabacum* and *N. rustica*, are of economic importance. The Indians of western North America, however, held *N. quadrivalvis* in high esteem for smoking purposes. Also, *N. sylvestris, N. alata* and a few others are used to some extent for ornamental purposes. Additional well-known species are *glauca, longiflora, glutinosa, trigonophylla*. Nearly all species of Nicotiana are native to America, but *N. suavolens* appears to be indigenous to Australia. All of the more important commercial types of tobacco are produced from *N. tabacum*. This is a coarse, rank-growing annual, reaching three to six feet or more in height. The leaves are simple, alternately arranged on the stem, very large but quite varied in size, ovate to lanceolate in shape, entire or with wavy margin, petiolated or sessile and decurrent. The number of leaves varies markedly in the different varieties but is not much affected by differences of environment. The green portions of the plant are covered with soft hairs either branched or single stalked, some of which are capitate and glandular, secreting a viscid, gummy substance. Stomata occur on both surfaces of the leaf. The inflorescence is a terminal panicle producing large flowers ranging in color from deep red through various shades of pink to white, a light pink being the more common color. Under favorable conditions flowering branches also develop from buds borne in the leaf-axils. The calyx of the flower is bell-shaped, four or five-cleft. The corolla tube is funnel-shaped with spreading and pointed lobes. The blossom is normally self-fertilized. The five stamens are attached to the base of the corolla tube. The stigma is capitate. The capsule is two to four-valved, bearing a very large number of seed. The seed are small, there being 300,000 to 400,000 in an ounce. There are numerous distinctive varieties of *N. tabacum* and of the leading commercial varieties there are many sub-varieties or local strains bearing distinctive names but usually differing among themselves only in minor details. In some instances, however, important commercial types of tobacco are produced from mixtures of distinct sorts designated collectively by the type name rather than by distinctive varietal names. This is notably true of Cuban and Turkish tobaccos. *N. rustica* is an annual with a much branched stem and large, ovate leaves with petiole. The corolla tube of the blossom is cylindrical with rounded lobes and is greenish yellow in color. The seed are about three times the size of those of *tabacum*. *Rustica* is decidedly earlier in maturing than is *tabacum*. It is not grown commercially in America but is extensively cultivated in India and in certain sections of Asia Minor and Russia, and to some extent in other European countries.

History.— Tobacco was widely used by the Indians at the time of the discovery of America by Columbus and relics of the Mound Builders show that pipe smoking was a very ancient custom among the aborigines. On landing in the West Indies in 1492 members of Columbus' crew observed that the natives smoked rolls of dried tobacco leaves. When the Spaniards landed in Mexico in 1519 they found the natives cultivating tobacco with care and skill. It was believed by them to possess great curative powers for such diseases as bronchitis, asthma and rheumatism. Other aromatic materials such as liquidambar were frequently mixed with tobacco for smoking purposes. The natives of the Orinoco forests of Venezuela understood the use of tobacco and the preparation and use of tobacco by the natives of Brazil are described in detail by André Thevet who visited that region in 1555. For smoking, the dried leaves were rolled into a small cylinder enclosed in a leaf of corn or palm. Similarly, when Cartier discovered what is now Canada he found the Indians drying tobacco leaves in the sun. The powdered leaves were smoked in pipes made of stone or wood. Early explorers traveling through the interior of the country found the habit of smoking very general among the aborigines from the Great Lakes to the Gulf of Mexico. The pipe of peace carried by the Indian tribes, which was an elaborately carved and decorated object, was smoked in common by those attending grand councils and was held very sacred. The tobacco cultivated by the Indians of North America to the east of the Mississippi was *N. rustica* while in Central and South America *N. tabacum* was the species principally grown. It has already been made clear that the American aborigines used tobacco in the form of cigars and for pipe smoking and, moreover, it is recorded that chewing the leaf was practised in some sections, while in South America the manufacture of snuff had reached a perfection which in some respects has never been surpassed. Thus, the American Indians had evolved methods of cultivating tobacco and preparing it in all forms which are now used. Finally, it is stated that a great North American tribe which dwelt near Lake Huron engaged in the cultivation of tobacco on a commercial scale, the product being sold to other tribes. According to early authorities, the Spaniards began the culture of tobacco in Haiti prior to 1535. Shortly afterward it was extended to the island of Trinidad whose product soon became famous in Europe. Tobacco culture was soon developed on a large scale in the West Indies and in Venezuela and Brazil. At least four distinct varieties of *N. tabacum* were grown, viz.: (1) A large broad-leaf type; (2) a long narrow-leaf «Ox-tongue» form; (3) a type resembling (2) but with broader leaves; (4) a type with very small leaves. Thus, prior to the settlement of Jamestown, the Spaniards and Portuguese had developed an important trade in tobacco between Europe and the West Indies and South America. John Rolfe began the culture of tobacco at Jamestown in 1612 from seed brought from South America or the West Indies and in 1619 20,000 pounds were shipped to England. The growing of tobacco in Maryland began about 1631 and soon became an important enterprise. These two States have continued to grow tobacco in large quantities up to the present day. The Virginia colonists at first grew the crop on the bottom lands of the tide-water region. As the settlers moved further inland, however, it was found that the more elevated and somewhat heavier soils produced tobacco better suited to trade requirements. Overproduction of tobacco soon became a serious menace to the welfare of the colonists and an inspection service was established in order to prevent the export of damaged or inferior leaf. Attempts were made also to limit the acreage grown but with indifferent success. It appears that the growers learned at a very early date the influence of the soil and the cultural and curing methods on the character of leaf tobacco produced. Thus, the selection of suitable soils, the proper spacing of the plants in the field, use of certain methods of manuring and following definite practices of topping, «suckering,» harvesting and curing came to be recognized in the first few decades of practical culture as being of fundamental importance. In the main, present-day cultural methods, therefore, differ from those of the early colonists in details rather than in fundamental principles. The exports of tobacco from Virginia had reached 18,000,000 pounds in 1700, and about 40,000,000 pounds in 1750 while at the outbreak of the Revolution the combined exports of Virginia and Maryland amounted to 100,000,000 pounds. Prior to the Revolutionary War the production of tobacco in the other colonies was not of much importance, but during the past century there was an enormous expansion in total production in the United States. New centres of production were developed and the crop as a whole became differentiated into a number of distinctive types. After the close of the Revolution pioneer settlers from Virginia and Maryland carried the culture of tobacco into Tennessee, Kentucky, Missouri and Ohio. The tobacco produced in western Kentucky and Tennessee, however, found its way to market through New Orleans while the product of eastern Ohio was sent to Baltimore. Missouri at one time became a leading tobacco-producing State although in recent years the production has fallen off to a nominal figure. During the first quarter of the last century the culture of cigar leaf tobacco began to assume importance in the Connecticut Valley and by the middle of the century the cigar tobacco districts of the Miami Valley of Ohio, the Gadsden area in Florida and the New York areas had become established. Next came the development of the Lancaster, Pa., district and, beginning about 1870, the culture of cigar leaf developed very rapidly in southern Wisconsin. As tobacco culture in Virginia was pushed forward onto the gray lands of the south central border counties and into North Carolina a lighter and finer-textured product was obtained. About 1825 began the use of charcoal in curing which had the effect of further improving the quality of the light-colored leaf and subsequently the charcoal was replaced by a system of flues for leading out of the barn the smoke from the fuel used in curing. In this manner began the development of the vast bright flue-cured tobacco industry. During the latter part of the century this industry spread into eastern North Carolina and South Carolina. Tobacco culture had been introduced into the Blue Grass region of Kentucky at an early date but the discovery of the White Burley variety in Brown County, Ohio, in 1864 revolutionized the industry in central Kentucky and southern Ohio and the Burley type soon came to be produced in enormous quantities. The outstanding event of the past quarter century in the industry is the development in the Connecticut Valley and in western Florida of the shade-grown cigar wrapper leaf industry, a very intensive and highly specialized agricultural enterprise. Turning to the introduction of tobacco into foreign countries, it appears that the plant was first grown in France in 1556 by André Thevet from seed taken back by him on his return from Brazil. The plant attracted little attention, however, till introduced and exploited at the royal court by Jean Nicot, Ambassador to Portugal, whose name became immortalized in the generic name of tobacco, *Nicotiana*. Tobacco also was first grown in Portugal and in Spain at about this time, and almost immediately was introduced into Belgium, the Netherlands and Rome. Upon his return to England from Virginia in 1585 Sir Richard Grenville introduced pipe smoking as practised by the Indians. For a full half century after its introduction into Europe tobacco was used almost exclusively as a medicinal agent and it was generally believed to possess wonderful curative properties. During the first half of the 17th century however, indulgence in tobacco became very general in most of Europe although in some instances strenuous efforts were made by the authorities to prevent its use. Amsterdam and Rotterdam became at the outset the leading distributing centres for American-grown tobacco. The culture and the use of tobacco were introduced into India, Persia and other Asiatic countries early in the 17th century.

Commercial Types of Tobacco.— The differentiation of leaf tobacco into types has reference primarily to the different uses of the leaf in manufacture. A further distinction is frequently made as to the district or locality in which the product is grown. In the United States there are eight important commercial types of tobacco, viz.: (1) cigar leaf; (2) dark fire-cured export; (3) White Burley; (4) bright flue-cured or yellow tobacco; (5) dark air-cured manufacturing; (6) Maryland and eastern Ohio export; (7) Virginia sun-cured; (8) perique. The cigar leaf type is used almost exclusively in the domestic manufacture of cigars. There are three sub-types of cigar tobacco: (1) wrapper leaf used as the outer covering of the cigar; (2) binder leaf used for holding the cigar's shape; (3) filler leaf which makes up the body of the cigar. Wrapper leaf is grown chiefly in the Connecticut and Housatonic valleys of New England and in the Gadsden-Decatur district of Florida and Georgia. Binder leaf is produced mainly in Dane, Rock, Vernon and Crawford counties of Wisconsin and in the Big Flats district of New York. The leading centres for the production of filler leaf are the Lancaster area of Pennsylvania, the Miami Valley district of Ohio and the Onondaga district of New York. The dark fire-cured type is exported to the extent of about 80 per cent of the total production, being unsuited for domestic manufacture except in making snuff and for limited use as a plug wrapper. This type is grown in some 20 counties of central Virginia, in the Clarksville and Hopkinsville, and the Paducah districts of western Kentucky and Tennessee and the Henderson or Stemming district of Kentucky. Great Britain is the heaviest purchaser of fire-cured leaf and the other principal foreign purchasers have been Italy, Germany, France, Spain, Austria and Belgium. This type of leaf is of heavy body, dark in color, rich in nicotine and possesses a distinctive creosotic or smoky smell and taste because of the combustion products absorbed from the smoke used in the process of curing. The White Burley is distinctly a domestic manufacturing type, but little of it being exported. It burns well, is of light body, rather neutral in flavor and yields a large proportion of light colored leaf. Its one most important characteristic, however, is its remarkable capacity for absorbing the liquid sweetening materials or sauces used in the manufacture of the sweetened type of plug chewing tobacco. For this purpose the Burley has no equal. It is also used very extensively in the manufacture of cut-plug smoking and fine-cut chewing tobaccos and in the production of cigarettes. White Burley is grown chiefly on the rich limestone soils of central and northern Kentucky and in southern Ohio. Considerable quantities, also, are produced in a few counties of western West Virginia and southeastern Indiana. The bright flue-cured or yellow tobacco has come to be the world's most important type in point of quantity consumed. In domestic manufacture the chief uses of this type are in the production of granulated smoking tobaccos, cigarettes and the flat type of plug chewing tobacco. It is our most important cigarette type. In recent years flue-cured leaf has been a very aggressive type in foreign markets and at the present time more than half the total production is exported, the largest foreign buyers being England, China and Canada. There are two subdivisions of the flue-cured producing district, namely, the Old Belt section, embracing the northern central counties of North Carolina and adjoining border counties of Virginia, all in the Piedmont region, and the New Belt section of eastern North Carolina and South Carolina, lying in the Coastal Plain region. The most distinctive characteristic of typical flue-cured tobacco is its lemon or orange yellow color. In the region of Kentucky and Tennessee lying between the Burley section to the east and the dark fire-cured section on the west there are two districts known as the One-sucker and the Green River which produce large quantities of dark air-cured tobaccos used both for domestic manufacture and for export. The one-sucker tobacco is used for the domestic manufacture of twist chewing tobacco and for the so-called rehandling export trade with South Africa, the West Indies and Central and South American countries. The Green River tobacco is used for the manufacture of long-cut chewing and for export to England. The Maryland and eastern Ohio tobaccos have been exported to Europe for centuries, France and The Netherlands being the chief purchasers. The Maryland leaf also is used to some extent in domestic manufacture. This tobacco is comparatively light in body and color, dry and chaffy and has good burning qualities but is rather characterless in aroma. In the eastern Ohio district the old piebald or spangled type has been largely replaced in recent years by White Burley. In a few counties in the vicinity of Richmond, Va., a dark type of leaf known as sun-cured is produced although in late years the old method of partially curing the leaf in direct sunlight has been largely abandoned in favor of air-curing. This tobacco is used in the manufacture of the flat type of chewing tobacco. Perique tobacco is grown only in Saint James Parish, La., and the total production is not large. This type deserves mention because of its distinctive aroma, due primarily to the unique method of curing employed by the growers. Perique is chiefly used in the preparation of fancy smoking mixtures to which it adds aroma. To the above-named domestic types entering into commerce must be added at least three foreign types of special importance, namely, the Cuban, the Sumatra and Java and the so-called Turkish. In a small area of Cuba located in the province of Pinar del Rio in the vicinity of San Juan y Martinez is grown the world's finest cigar leaf, noted for its remarkable aroma. This district is known as the Vuelta de Abajo and the outlying tobacco-producing territory is designated as Semi-vuelta. Other leading Cuban districts are the Partidos of Habana province and the Remedios of Santa Clara province. Porto Rico, the Bahia district of Brazil and portions of the Philippines also produce cigar tobacco of high merit though they do not equal the best Cuban. On the east coast of Sumatra and in portions of Java a very fine grade of cigar wrapper leaf is grown and several million pounds of this product are imported into this country each year for the manufacture of lower and medium-priced cigars. Because of the thinness of leaf, fineness of texture and veins and general uniformity of the grades this tobacco has a great wrapping capacity per pound. In the portion of southern Macedonia around the port of Cavalla and other nearby towns and in the Smyrna, Trebizond and Samsoun districts of Asia Minor are grown the finest cigarette tobaccos in the world. The so-called Turkish cigarettes are made from blends of these tobaccos. Egyptian cigarettes also are made from the Turkish types and tobacco is not grown in Egypt. The Macedonian, Smyrna and Samsoun tobaccos are imported into the United States in large quantities.

Culture of Tobacco.— The tobacco plant may be grown under a wide range of soil and climatic conditions but, on the other hand, the characteristics of the leaf of commercial importance are greatly influenced by both soil and climate. These facts explain the existence of so many different commercial types of tobacco each suited to special purposes of manufacture. Cultural methods, also, affect the character of leaf obtained so that these methods are modified in the different districts according to the special requirements of the type grown, although certain general features are common to all sections. The tobacco seedlings must be grown in a specially prepared seed bed which may be either a hotbed or more commonly a cold frame. The soil must be mellow and friable and must be made rich. The time of planting ranges from January in the South through the month of April in Northern districts. The seed are sown at the rate of about a heaping teaspoonful to 25 square yards of seed bed and are covered only very lightly. The beds are covered with glass or with «tobacco cloth» to protect the young seedlings. When the seedlings have attained sufficient size, usually 6 to 10 weeks after the seed have been planted, they are transplanted to the field either by hand or machine. At the time of transplanting each plant must be watered unless the soil is wet. The plants are set in rows three to four feet apart while the distance allowed between the plants in the row varies from 14 to 16 inches for some of the cigar tobaccos up to three and one-half to four feet for the fire-cured type. The character and condition of the soil used for tobacco is of special importance. Good drainage is essential in all cases. Broadly speaking, cigar wrapper and binder leaf, Maryland tobacco and the flue-cured type are grown on light sandy and sandy loam soils, with sandy or sandy clay subsoils. In New England the Merrimac series of soils are widely used, while in Maryland the Norfolk and in the flue-cured district the Norfolk and Durham series are of special importance for tobacco. In the cigar filler district of Pennsylvania and in the Burley region of Kentucky fertile loams of limestone origin, particularly the Hagerstown loam, are chiefly used. Clay loams of the Miami series are typical tobacco soils of the Ohio cigar filler district. The dark fire-cured and air-cured export and manufacturing tobaccos are grown on rather heavy silt and clay loams usually reddish or brownish in color, with clay subsoils. Both the kind and the quantity of fertilizer applied to the tobacco crop are important. An excess of nitrogen injures the quality of the leaf, especially in the case of the flue-cured type. At least a part of the nitrogen should be derived from organic sources such as cotton-seed meal or dried blood. A liberal supply of potash in the form of sulphate or carbonate favors good burning qualities and reduces susceptibility to leaf spot diseases. Chlorine tends to hinder free combustion in the cured tobacco. Only quickly available forms of phosphoric acid should be used in order to ensure proper «ripening» of the leaf. In Connecticut heavy applications of fertilizers furnishing 100 to 150 pounds each of nitrogen, phosphoric acid and potash per acre are commonly employed while in Southern districts 20 to 40 pounds of nitrogen and potash and 40 to 80 pounds of phosphoric acid per acre are applied to the crop. Barn manure, also, is widely used in Northern districts. Liming is less essential for tobacco than for many other crops though possibly beneficial under some conditions. The soil is tilled for tobacco about the same as for corn or cotton. When the flower head begins to develop or somewhat later the plants are «topped» by breaking off the top of the stalk carrying the flower head and upper leaves, in order to force a better development of the leaves remaining on the plant. Cigar wrapper and binder tobaccos, White Burley and Maryland tobacco are topped high, leaving 16 to 20 leaves on the plant, while the heavy fire-cured type is topped to only 10 to 14 leaves and other types are topped to intermediate heights. The suckers or branches which develop in the axils of the leaf also must be broken off by hand. It is important to harvest the crop at the right stage of maturity. As the leaves ripen they take on a lighter green color and become more or less mottled with light-colored flecks. They also tend to crack when folded between the fingers. There are two methods in general use in harvesting the crop. In the first method the stalk is cut off near the ground and the inverted plants are attached to four-foot sticks either by means of cord or hooks properly spaced on the sticks, or by forcing the stick through the butts of the stalks by means of a removable metal spear head, or, finally, by splitting the stalks from the top to near the base and simply placing the plants astride the sticks. Each stick carries six to 10 plants and thus laden the sticks are arranged 6 to 12 inches apart on the tier poles of the barn. In the second method the leaves are plucked from the plant as they ripen, beginning at the bottom and taking two to five leaves at each picking. The field is thus gone over three to five times at intervals of a week or 10 days. The leaves are strung on cord by piercing the base of the midrib with a needle or the cord is merely looped around the basal ends of the leaves. The free ends of the cord are attached to either end of a four-foot stick, each stick and cord carrying 20 to 40 leaves. Curing, which must be carried out under proper conditions of temperature and moisture supply, is effected in specially constructed curing barns. Three distinctive methods are practised, known as air-curing, flue-curing and fire-curing. In all cases the process must be so regulated as to develop the desired properties in the tobacco leaf. In air-curing natural atmospheric conditions are largely depended upon and little or no artificial heat is employed. The barns are comparatively large and are provided with a maximum of ventilation. From three to 12 weeks are required to complete the process of air-curing. This method is applied to all cigar tobaccos, Maryland tobacco, White Burley and the dark manufacturing types. For flue-curing the barns are small in size, tightly constructed and are provided with a system of metal pipes by means of which artificial heat may be freely applied without allowing smoke to come in contact with the tobacco. Heat is applied throughout the curing and the temperature is carefully regulated, beginning with 90–100° F. and ending with 180° or even 220° F. The whole process is completed in three to five days. In fire-curing heat is supplied by making open fires on the floor of the barn, thus allowing the smoke to come in contact with the tobacco, to which it imparts a characteristic odor. The barns should be tightly constructed but they should be provided with ventilators. In practice heat is not applied until the tobacco has been hanging in the barn for two or three days and the fires are kept going for only a few days at a time. Alternate periods of air-curing and firing are thus continued till the curing process is completed. After curing in the barn is completed the tobacco leaf is too brittle to handle without breaking except after a period of damp weather or when moisture is applied artificially. Under suitable moisture conditions the leaf becomes pliable so that the crop can be handled in preparation for market. After the leaves have been stripped from the stalks they are separated into various grades according to size, color and other important elements of quality. The number of grades made by the grower ranges from two to 10 or more, according to the type and value of the crop. After the grading is completed the leaves are tied into small bundles or «hands» by securely wrapping a folded leaf around the butt ends of the leaves in the bundle. There are several different methods of marketing the various types of leaf tobacco. In the case of cigar tobaccos and, to a limited extent, the dark air-cured and fire-cured types, the buyer inspects and bargains for the crop on the farm, the grower delivering the tobacco at the buyer's receiving warehouse. In the South and, to an increasing extent, in the Western districts the «loose leaf auction system» prevails. Under this system the various grades of the grower are placed in separate lots on the warehouse floor at market centres and sold at auction on a commission basis. In a third system which has been extensively employed, the tobacco, put up in standard containers, is sold from carefully drawn samples without the buyer having seen the contents of the package until delivery has been effected. The sale is made either by auction or by private bargaining. There are three standard containers in which leaf tobacco is delivered to the manufacturers, namely, the box or case, the bale and the hogshead. Cigar tobaccos are packed in cases and bales and Turkish tobacco, also, is put up in bales, while the bulk of other tobaccos is packed in hogsheads. In all cases, after having been packed, the tobacco goes through an important fermentative or aging process which develops the aroma and otherwise improves the quality. In some cases, however, the tobacco is put through a preliminary, more active fermentation in large heaps or bulks before it is packed for storage or transportation. The extent or degree of the fermentation is controlled largely by regulating the moisture contents of the tobacco. The tobacco plant throughout its period of growth is subject to injury by numerous insect pests and parasitic diseases. Among the more important insect enemies are the cutworm, wireworm, flea-beetle, hornworm and budworm. The cutworm and wireworm are best controlled by rotation of crops and the hornworm and budworm by the use of arsenical insecticides or by hand picking, while no effective remedy has been found for the flea-beetle. The tobacco-beetle (not the tobacco flea-beetle), a serious pest in all forms of cured leaf and manufactured tobacco, is best controlled by the use of heat under certain conditions or by fumigation. As important diseases of the tobacco plant should be mentioned bacterial wilt, controlled by rotation of crops; root rot, the most effective remedy for which is the use of resistant varieties; a fusarium root disease, for which a remedy has not yet been developed; "sore shank," a decay of the stem, most effectively combated by rotation of crops; mosaic, an infectious disease disseminated by plant lice and other insects and through the handling of diseased plants by laborers; frenching, a malnutrition disease, the exact nature of which has not been determined; leaf spot, of which there are several forms, becoming destructive only under certain environmental conditions. During the curing process and in all subsequent stages tobacco is subject to injury by molds or decay, which usually can be prevented by proper regulation of the moisture supply.

Production, Trade Movement and Consumption of Tobacco.— The estimated normal production of tobacco for all countries growing notable quantities is shown in Table I.

TABLE I.— WORLD'S PRODUCTION OF TOBACCO.

COUNTRY	Production (pounds)
Canada	15,000,000
United States (Continental)	1,150,000,000
Cuba	75,000,000
Santo Domingo	25,000,000
Porto Rico	10,000,000
Mexico	35,000,000
Argentina	35,000,000
Brazil	100,000,000
Colombia	20,000,000
Paraguay	15,000,000
Russia	250,000,000
Austria-Hungary	175,000,000
Germany	60,000,000
France	50,000,000
Bulgaria	30,000,000
Belgium	20,000,000
Greece	20,000,000
Italy	20,000,000
Rumania	20,000,000
British India	1,000,000,000
China	500,000,000
Dutch East Indies	200,000,000
Japan	120,000,000
Philippines	100,000,000
Turkey	90,000,000
Korea	35,000,000
Algeria	20,000,000
Union of South Africa	15,000,000
Total	4,205,000,000

The average annual acreage, production and value of tobacco for the 10-year period ending with 1918 in each of the leading tobacco-growing States is shown in Table II.

TABLE II.— PRODUCTION OF TOBACCO IN THE UNITED STATES, BY STATES.

STATE	Acreage	Production (pounds)	Value per acre
Massachusetts	6,600	10,650,000	$356 00
Connecticut	19,550	31,050,000	381 00
New York	4,200	5,200,000	170 00
Pennsylvania	40,100	54,900,000	167 00
Ohio	97,200	86,950,000	118 00
Wisconsin	42,850	49,650,000	150 00
Maryland	26,000	18,400,000	94 00
Kentucky	442,500	376,250,000	104 00
Tennessee	92,850	71,100,000	76 00
West Virginia	14,000	10,900,000	114 00
Indiana	17,650	15,600,000	115 00
Virginia	185,600	134,000,000	100 00
North Carolina	262,100	167,000,000	113 00
South Carolina	46,000	31,800,000	96 00
Florida	3,600	3,300,000	316 00

The production of tobacco in the United States by types for the year 1918 is found in Table III.

TABLE III.— PRODUCTION OF TOBACCO BY TYPES IN 1918.

TYPE AND DISTRICT	Production (pounds)
I. Cigar types:	
New England	52,500,000
New York	3,760,000
Pennsylvania	64,750,000
Ohio-Miami Valley	67,300,000
Wisconsin	65,100,000
Georgia and Florida	7,080,000
II. Chewing, smoking, snuff and export types:	
Burley	269,100,000
Paducah	76,000,000
Henderson or Stemming	85,000,000
One-sucker	45,000,000
Clarksville and Hopkinsville	77,000,000
Virginia sun-cured	11,200,000
Virginia fire-cured	57,050,000
Flue-cured, old belt	171,800,000
Flue-cured, new belt	248,500,000
Maryland and eastern Ohio export	28,700,000
Perique-Louisiana	125,000

The present normal production of tobacco in the United States is placed at 1,150,000,000 pounds, grown on 1,400,000 acres and having a farm value of $1,380,000,000. Nearly all of this crop is grown in 15 States. Kentucky produces fully a third of the entire crop and Virginia and North Carolina together produce nearly another third. Lancaster County, Pa, with a production of nearly 40,000,000 pounds, is the banner tobacco-growing county of the United States. The crop as a whole is made up approximately of 28 per cent flue-cured, 25 per cent White Burley and 20 per cent each of cigar leaf and the dark fire-cured export type, the remainder consisting of Maryland export and dark-air-cured manufacturing leaf. Considerable quantities of fine cigar and cigarette leaf tobacco are imported into the United States from foreign countries and shipped in from non-contiguous territory. The imports for 1914 as given in Table IV may be taken as representing approximately the normal pre-war import requirements of the tobacco industry. The war proved a disturbing factor in the tobacco trade and while the demand was greater than ever before it was not reflected in the imports.

TABLE IV.— IMPORTS AND SHIPMENTS FROM NON-CONTIGUOUS TERRITORIES OF TOBACCO FOR THE YEAR 1914.

IMPORTS	Quantity	Value
Leaf tobacco:		
Netherlands (Sumatra and Java leaf), pounds	7,688,514	$9,744,750
Cuba	25,725,202	14,706,246
Turkey in Europe	9,564,203	5,210,546
Turkey in Asia	11,577,199	3,804,066
Shipments from Porto Rico:		
Leaf tobacco, pounds	6,353,528	2,805,532
Stems and trimmings	1,975,231	222,416

From the earliest days of the colonies, tobacco has always been an important article of export in the international trade of the United States. For many years Great Britain has been the heaviest foreign purchaser of American tobacco. Statistics for the year 1913 may be taken as indicating the normal distribution of our exports of leaf tobacco. The data are shown in detail in Table V,

TABLE V.— EXPORTS OF LEAF TOBACCO FOR THE YEAR 1913.

EXPORTS	Quantity	Value
United Kingdom, pounds...	175,026,020	$20,638,282
France....................	48,154,511	4,152,502
Italy.....................	40,567,680	5,517,813
Germany...................	31,697,427	3,972,062
Netherlands...............	28,997,185	2,908,392
Spain.....................	21,384,529	1,405,988
Canada....................	18,975,921	3,291,268
China.....................	11,940,865	2,044,615
Belgium...................	11,302,150	1,358,866
Japan.....................	5,038,389	726,561
All other countries.........	51,286,989	6,921,545
Total................	444,371,661	$52,937,849

The international trade of the United States in tobacco manufactures, also, is considerable, the chief items being the imports of cigars from the Philippines and Cuba and the exports of cigarettes to Asiatic countries. In 1917 the imports of Manila cigars were, in round numbers, 200,000,000, worth $3,863,000. The normal imports of cigars from Cuba amount from 40,000,000 to 45,000,000 annually, valued at $3,500,000 to $4,000,000. Approximately 175,000,000 cigars are shipped into continental United States each year from Porto Rico and these cigars are valued at about $6,500,000. Nearly 5,000,000,000 cigarettes having a value of $9,600,000 were

TABLE VI.— LEAF TOBACCO USED IN THE DOMESTIC MANUFACTURE OF CIGARS, CIGARETTES, CHEWING AND SMOKING TOBACCO AND SNUFF.

YEAR	Cigars	Cigarettes	Chewing and smoking tobacco and snuff	Total
	pounds	*pounds*	*pounds*	*pounds*
1917...	169,575,949	133,505,911	354,984,236	658,066,105
1916...	159,067,912	93,338,243	349,198,684	601,604,839
1915...	146,448,331	66,791,387	338,448,062	551,687,780
1914...	158,757,457	62,209,366	333,883,676	554,850,499
1913...	162,985,758	56,558,868	338,870,673	558,415,299
1912...	149,690,650	47,117,111	350,549,373	547,357,134
1911...	149,917,245	38,598,128	346,544,032	535,059,444
1910...	141,116,460	31,272,319	350,480,904	425,869,679
1909...	136,670,104	23,714,845	344,325,030	504,709,975
1908...	130,440,248	20,665,921	331,907,336	483,013,505

exported to China in 1917 and in 1918 the number had increased to some 7,500,000,000, worth over $12,000,000. More than a billion cigarettes, also, are exported annually to the Straits Settlements. Total exports of plug tobacco and smoking tobacco amount to some 5,000,000 and 2,500,000 pounds, respectively. Our export trade in cigars is of little importance. It now remains to consider the quantity of leaf tobacco consumed in domestic manufactures. The quantities thus used in the manufacture of cigars, cigarettes, smoking and chewing tobacco and snuff are shown in Table VI, for the 10-year period ending with 1917. These figures, which are based on reports of the Bureau of Internal Revenue, do not include the quantities of leaf tobacco consumed in bonded manufacturing warehouses. The tobacco consumed in these establishments in 1917 amounted to nearly 18,000,000 pounds.

The output of the various forms of manufactured tobacco produced from the quantities of leaf tobacco consumed, as above indicated, is set forth in Table VII. In addition to the tobacco leaf large quantities of licorice, sugar and other materials are used in the manufacture of chewing and smoking tobacco. The figures show more or less of an increase in most forms of manufactured tobacco but the outstanding feature of the table is the enormous increase from year to year in the output of cigarettes. In addition to the quantities given in Table VII, which are based on reports of the commissioner of internal revenue, the various forms of tobacco were manufactured to some extent in bonded manufacturing warehouses. There were thus manufactured in 1916 4,594,662,940 cigarettes and 87,654,149 cigars, making a total output of 29,907,149,551 cigarettes and 8,020,264,340 cigars for that year. Thus, the indicated total of cigarettes manufactured in 1917 is in excess of 40,000,000,000.

In 1914 there were 13,951 establishments, with a capital of $303,840,000, engaged in the manufacture of tobacco in the United States. Salaries and wages paid to 195,694 persons engaged in the industry amounted to $99,980,000 and the total value of manufactured products was $490,165,000. Manufactured tobacco is an important source of governmental revenue in the United States. During the decade ending with 1917 the internal revenue collected on tobacco ranged from $49,862,754 in 1908 to $88,063,948 in 1916 and $103,201,592 in 1917.

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TABLE VII.— PRODUCTION OF CIGARS, CIGARETTES, SNUFF AND TOBACCO.

YEAR	Cigars	Cigarettes	Tobacco				
			Plug	Twist	Fine-cut	Smoking	Snuff
	number	*number*	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*
1917.......	8,527,119,269	35,355,860,177	179,413,107	15,174,350	11,286,561	243,586,164	33,516,802
1916.......	7,932,610,191	25,312,486,611	165,630,918	15,998,082	10,846,358	239,720,776	33,969,594
1915.......	7,564,323,265	17,980,164,482	150,658,608	14,829,376	10,045,001	234,927,827	31,898,407
1914.......	8,248,891,047	16,869,520,463	156,502,776	15,987,339	10,961,100	226,888,866	30,595,640
1913.......	8,530,916,995	15,570,798,437	160,338,510	14,893,789	10,934,526	220,809,688	32,808,056
1912.......	8,099,488,730	13,183,693,899	160,248,195	15,531,133	11,006,561	217,330,409	31,363,651
1911.......	8,262,337,873	10,486,379,819	160,895,589	13,845,761	11,027,986	209,367,475	28,943,754
1910.......	7,928,234,051	8,663,709,480	170,352,625	14,580,022	12,857,930	214,056,402	31,445,178
1909.......	7,710,798,474	6,836,652,435	173,418,223	14,625,975	12,481,100	202,370,654	28,454,958
1908.......	7,561,419,809	5,760,501,296	164,712,863	14,476,734	12,086,725	192,229,890	24,035,738

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WIGHTMAN W. GARNER,
Physiologist in Charge of Tobacco Investigations, Bureau of Plant Industry, United States Department of Agriculture.

TOBAGO, tō-bā'gō, British West Indies, an island of the Lesser Antilles, situated 20 miles northeast of Trinidad. It is about 24 miles long by seven miles wide, with an area of 114 square miles. It is hilly, rising at one point to a height of 2,000 feet. The soil is fertile and well cultivated. The chief products are sugar, rum, cocoanuts, rubber, cacao, cotton and tobacco. The capital and chief port is Scarborough, on the south coast, where steamships to Guira make stops. The island has been in British possession since 1814, and in 1889 it was united with the colony of Trinidad. Pop. about 21,000.

TOBASCO, a meat sauce made of peppers, originally manufactured in Louisiana by Col. John McIlhenny in 1868.

TOBIKHAR, tō-bĭk-här'. See SHOSHONEAN INDIANS.

TOBIT, Book of, one of the Old Testament books rejected as apocryphal by the Jews and Protestants, but received into the canon by the Roman Catholics. It contains an account of some remarkable events in the life of Tobit, a Jew carried captive to Nineveh, and his son, who is named Tobias. Ewald ascribes the book to a Palestinian Jew who wrote in Hebrew, and suggests as the date of its composition the middle of the 4th century before Christ. The earliest known text is in Greek. See BIBLE.

TOBOGGAN, a sled-like vehicle, often formed of a single piece of broad flat wood, of birch or basswood, curved up and backward at the front end, and used for sliding down slopes of snow. It is commonly from five to eight feet long, about 15 or 16 inches in width if formed of one piece, or wider if formed of two or more. The curved portion in front is usually fastened by thongs of hide or gut, and the toboggan is strengthened by cross-pieces of hard wood strapped to the body at short distances. Toboggans originated with the Indians, who used them for hauling packs over the snow, and the name is still applied to a class of sleds drawn by dogs. But the toboggan of to-day is chiefly used in the sport of coasting down prepared slides, a popular pastime in Canada and other countries in high latitudes.

TOBOL, tō-bŏl', Asia, a river of Siberia, tributary to the Irtish, which rises in the southern Ural slopes, in Russian central Asia, flows northeast, and after a course of 750 miles empties into the Irtish opposite Tobolsk. It is navigable for more than half its length, but is covered with ice from November to May; its chief affluents are the Uj-Isset, Tura and Tawda. The Trans-Siberian Railway crosses the river at Kurgan.

TOBOLSK, tō-bŏlsk', Asia, in Siberia, (1) capital of a government of the same name, on the Irtish where it joins the Tobol, about 350 miles northwest of Omsk. The principal buildings are the churches, governor's residence, bishop's palace, municipal offices, arsenal, barracks, bazaar and hospital; besides a prison used as a depot for Siberian exiles, assembled from all parts of the country, an episcopal seminary, theatre, gymnasium, etc. The manufactures include bricks, soap and tallow. The trade is unimportant. The town is partly fortified. Pop. 25,200. (2) The government of Tobolsk, in northwestern Siberia, contains an area of 535,739 square miles. The Arctic Ocean borders the northern coast; the principal rivers are the Obi and Irtish, which are navigable when not frozen over. The chief occupation of the inhabitants is agriculture and cattle-raising; fishing and hunting in the north. Pop. 2,885,700.

TOCANTINS, tō-kän-tēnz', Brazil, a river rising in the southern part of the state of Goyaz, and flowing north through Goyaz, Cayapo and Pará, emptying into the Atlantic Ocean through the Rio Pará, the southern estuary of the Amazon delta. On the northern boundary of Goyaz the river receives from the left the Araguayá, which is considerably larger than the main stream. From the source of the Araguaya in the Cayapo Mountains in Matto Grosso to the Atlantic Ocean is fully 2,200 miles, constituting one of the great rivers of the world. The Tocantins is 1,600 miles long, and though interrupted by falls and rapids, it is navigable in stretches aggregating 1,100 miles. Its estuary is 140 miles long, and receives numerous channels from the Amazon, together with which it separates the island of Marajo from the mainland. The country through which these great twin rivers flow is undeveloped, there being not a single important city on the banks, except Pará at the mouth.

TOCQUEVILLE, tŏk'vĭl (Fr. tŭk-vēl), **Alexis Charles Henri Clérel de,** French statesman and writer: b. Verneuil, 29 July 1805; d. Cannes, 16 April 1859. He was originally destined for the military profession, but exchanged it for that of law. In 1827 he was appointed an assistant magistrate at Versailles. In 1831 he was commissioned by the French government to proceed along with his friend, M. Gustave de Beaumont, to America, and to investigate and report upon the penitentiary system of the United States. The results of the inquiry were published in 1833 under the title 'Du Système Pênitentiaire aux Etats-Unis et de son Application en France.' This, however, was only the precursor of the greater and more celebrated work 'La Démocratie en Amérique' (1835), to which the Montyon prize of the French Academy was awarded in 1836, and which, by 1850, had run through 13 editions. It was the first systematic analysis of democracy as exemplified in the institutions and political relations of the United States, and was translated into the principal European languages. Tocqueville was in 1839 elected to a seat in the Chamber of Deputies, and ranged himself with the opposition. After the Revolution of 1848 he was nominated deputy from the department of La Manche to the National Assembly, where he voted always against the propositions of the ultra-democratic party. In the Cabinet of 2 June 1849, he accepted the portfolio of Foreign Affairs, but resigned it the same year, after holding it for five months. After the *coup d'état* of 2 Dec. 1851, he lived retired from public affairs, and devoted his leisure to the production of 'L'Ancien Régime et la Révolution,' published in 1856. His complete works appeared in 1860–65. Consult Jaques, 'Alexis de Tocqueville' (1876); 'Souvenirs d'Alexis de Tocqueville' (1893); and D'Eichtal, 'Alexis de Tocqueville et la Démocratie Libérale' (1897).

TOCSIN, a bell sounded with quick strokes for the purpose of alarm. The word is derived from the French, and the use of the tocsin as a signal to arouse the people was so common during the French Revolution that the word has come to be proverbially used for any loud sound or call marking the commencement of an important event.

TODAS, or TUDA, a singular race of people inhabiting the upper part of the Neilgherry Hills in southern India. They are pastoral in their habits and possess a queer unwritten language. Their religion is the worship of the sun and of departed spirits. They follow the practice of polyandry in both its forms — the brothers of one family having one common wife, yet receiving the right, at certain seasons, of temporary husbands to the women of the subject villages. They are a tall, well-proportioned and a fine muscular race of men, are dominant over the neighboring tribes and receive from them a "goodoo" or tribute of one-sixth of their crops, the Todars holding aloof from tillage of the soil. They have slowly increased in number since 1858 when a count of them showed only 337, a recent estimate placing their number at 750.

TODD, Alpheus, Canadian author and librarian: b. England, 1831; d. Ottawa, Canada, 22 Jan. 1884. He removed with his parents to Canada in 1833; was for some time assistant librarian of the legislative assembly of Upper Canada, and in 1858 he became chief librarian. Upon the Confederation he was appointed to that office with the Dominion Parliament. He was also a writer of high authority on constitutional law and Parliamentary government. Author of 'The Practice and Privileges of the Two Houses at Toronto' (1839); 'Parliamentary Government in England' (2 vols., 1867–69), etc.

TODD, Charles Burr, American author: b. Redding, Conn., 9 Jan. 1849. He received his education in the public schools. For many years he was special writer on the New York *Evening Post*. In 1895 he was secretary to the commission appointed by Mayor Strong of New York to publish the early records of New York City. His published works are 'History of the Burr Family in America' (1879); 'History of Redding, Conn.' (1880; 2d ed., 1906); 'Life and Letters of Joel Barlow' (1886); 'Story of the City of New York' (1895); 'Story of Washington, the National Capital' (1897); 'Lance, Cross and Canoe in the Valley of the Mississippi,' 'Brief History of New York' (1899); 'The True Aaron Burr' (1902); 'The Real Benedict Arnold' (1903); 'In Olde Connecticut' (1905); 'In Olde Massachusetts' (1907); 'In Olde New York' (1907); 'The Washington Crossing Sketch Book' (1914); 'Sketches of the Delaware Valley' (1916).

TODD, David, American astronomer: b. Lake Ridge, N. Y., 19 March 1855. He was graduated from Amherst in 1875 where he became professor of astronomy in 1881. From 1882 to 1887 he held a similar post at Smith College. In order to make astronomical observations he has conducted expeditions to Texas in 1878, transit of Venus, Lick Observatory 1882, to Japan in 1887 and again in 1896, to West Africa in 1889–90, to Tripoli, Barbary, in 1900 and 1905, to the Dutch East Indies in 1901, to the Andes of Chile and Peru in 1908 and to Russia in 1914. He is the author of several textbooks on astronomy, also 'Stars and Telescopes' (1899); 'Lessons in Astronomy' (1902), also articles in magazines and reviews.

TODD, Henry Alfred, American philologist and educator: b. Woodstock, Ill., 13 March 1854. He was graduated at Princeton University in 1876 and later studied at the universities of Paris, Berlin and Madrid, taking his Ph.D. at Johns Hopkins University in 1885. He was professor of Romance languages at Leland Stanford Junior University in 1891–93; and in 1893 he became professor of Romance philology at Columbia University. He was one of the founders of the *Romantic Review* in 1910; was a member of the advisory council of the Simplified Spelling Board; and in 1906 was president of the Modern Language Association of America. He has edited numerous works in the Romance languages.

TODD, Mabel (Loomis), American author: b. Cambridge, Mass., 10 Nov. 1858. She edited the 'Poems' (1890–96) and 'Letters' (1894) of Emily Dickinson and a 'Cycle of Sonnets' (1896) by an anonymous author; also Steele's 'Popular Astronomy' (1899). Her original writings include 'Total Eclipses of the Sun' (1894) and 'Corona and Coronet' (1898); 'A Cycle of Sunsets' (1909). The results of study of the Ainu aborigines in Kitami province, Japan, appeared in various magazine articles.

TODD'S TAVERN, Engagements at. The Virginia campaign of 1864 began on 4 May by the advance of the Army of the Potomac across the Rapidan, the cavalry divisions of Generals Gregg and J. H. Wilson leading.

Wilson crossed the Rapidan at Germania Ford, and marched rapidly by Wilderness Tavern to Parker's Store, from which he sent a reconnoissance toward Mine Run, the rest of his division going into bivouac. During the night he was ordered by General Meade to advance in the direction of Craig's Church, leaving one regiment to hold Parker's Store. Just beyond Craig's Church Wilson encountered Rosser's Confederate cavalry, which was driven back two miles, and at noon, as he had heard nothing of the approach of Meade's infantry, and his own position was threatened, he began to withdraw to Parker's Store, when he heard that the regiment left there had been attacked by Confederate infantry, and that he was cut off from communication with General Meade's infantry. He determined to withdraw on the Catharpin road, by way of Shady Grove Church, to Todd's Tavern, on the Brock road. Before he was fairly on the road he was attacked in heavy force and followed by cavalry, but he reached Todd's Tavern by crossing the Po River at Corbin's bridge. A part of his command was cut off, but came in later in the day. As he approached Todd's Tavern he was relieved by Gregg's division, which, by Meade's direction, Sheridan had sent to assist him, and Stuart's cavalry, which was closely following Wilson, was driven back by Gregg to Shady Grove Church, about four miles. Sheridan was holding the left flank of the army, and covering its trains, while it was grappling with Lee in the Wilderness, and on the 6th had two divisions at Todd's Tavern, covering the roads centring at this point, where he was attacked early in the day by Stuart, who was anxious to get at Grant's flank and his wagon train, but his successive attacks were repulsed. Meade, anxious about his left, directed Sheridan to draw back from Todd's Tavern, closer to the trains, which Sheridan did in the afternoon, and the Confederate cavalry occupied Todd's Tavern. Preliminary to Grant's movement from the Wilderness to Spottsylvania Court House was the necessity to hold Todd's Tavern, which was midway between the two places and on the direct road connecting them; and on the 7th two brigades of Gregg's division and two of Merritt's, dismounted and fighting on foot, attacked Stuart and, after a sharp and closely contested action, drove him from Todd's Tavern, with severe losses on both sides, Fitzhugh Lee's division retreating in the direction of Spottsylvania Court House and Wade Hampton's southward to Corbin's bridge of Po River. Sheridan withdrew and encamped, Gregg's and Merritt's divisions in the open fields to the east of Todd's Tavern. Very early on the morning of the 8th Gregg was put in position to guard the roads from the south and Merritt's division renewed the engagement with Fitzhugh Lee on the Spottsylvania Court House road to open the way for the advance of Warren's Fifth corps from Todd's Tavern to the Court House. Merritt became severely engaged, but slowly gained ground until about 6 A.M., when he was relieved and Robinson's division of Warren's corps took the advance. Hancock's Second corps, following Warren's, reached Todd's Tavern at 9.30 A.M., and took position covering the Brock road, Catharpin and Spottsylvania roads, and began to intrench, holding the extreme right of the army. At 11.30 A.M. Gen. N. A. Miles' brigade, with Gregg's cavalry brigade and a battery, moved out on the Catharpin road toward Corbin's bridge, and when half a mile from it and one and one-half miles from Todd's Tavern, the head of column was opened upon with artillery from the heights on the south side of Po River. Miles formed line, his artillery replied to that of the enemy, there was a skirmish with Wade Hampton's cavalry, which was kept at bay, and at 5.30 P.M., when Miles began to withdraw, he was attacked by Mahone's division of infantry and fell back fighting to Todd's Tavern. Consult 'Official Records' (Vol. XXXVI).

E. A. Carman.

TODDY, or PALM-WINE, a drink made in tropical countries from the sap of various palms, especially when in a fermented state. The word is of Hindustani origin and is generally applied in India to the substance used as yeast to leaven bread. In the Malayan Archipelago, toddy is the sweet juice of the flower sheaths of *Arenga saccharifera.* In Brazil the majestic buriti, or murichi palm (q.v.), is felled, and cavities are dug in the stem in which to collect the sap, from which a fermented liquor is made. This has led to the use of the name of wine-palm for this tree. The spadix of the useful *Nipa frutescens* yields toddy which is changed into vinegar by one process, into arrack by another and may also be converted into a delicious syrup, thick, frothy and clear, with a slightly saline flavor. Sugar is made from this syrup by evaporation. The toddy or jaggery-palm (*Caryota urens*), a palm crowned by drooping bipinnate leaves, with wedge-shaped leaflets, furnishes a similar sap when the flowering stems are cut. This, like that of the nipa, can be boiled down into syrup and will yield a coarse brown sugar known as jaggery or goor. The sap is fermented for the toddy and further distilled for arrack. The cocoanut (*Cocos nucifera*), the palmyra palm (*Borassus flabelliformis*), the date (*Phœnix dactylifera*), and the wild date (*Phœnix sylvestris*), all yield toddy in India, the latter being grown extensively in Bengal, for the sake of this drink and the sugar extracted from it; it is said that the sap can be induced to flow from the upper portion of the stem for many years. The West Africans make their toddy from *Raphia vinifera.*

The word toddy was applied by the Scots to a drink made of whisky and hot water, sweetened. Burns uses the term in 'The Holy Fair.' Whisky and cold water, properly called grog, is also known by this name. Toddy-Cat is the name given in southern India to the palm-civet on account of its alleged fondness for palm-juice.

TODDY-BIRD, a swallow-shrike (*Artamus fuscus*) of India and Ceylon. It is about seven inches long, of dusky plumage and is most abundant in wooded districts, especially where palm trees abound, more particularly the Palmyra or toddy palm, from which it takes several of its popular names.

TODDY-CAT, one of the civets (*Paradoxurus typus*), common throughout the greater part of India, Ceylon, Burma and the Malayan region, which dwells mainly in the Palmyra or toddy palm-groves. See Toddy.

TODHUNTER, Isaac, English mathematician: b. Rye, 1820; d. Cambridge, 1 March 1884. He was graduated from London University in 1842 and from Saint John's College, Cambridge, in 1848. He was elected a Fellow of his college in 1849 and became a lecturer and tutor. He was elected a fellow of the Royal Society in 1862. Todhunter was a man of high attainments in various branches of learning, but is best known as the author of numerous mathematical textbooks. His most important works are 'Treatise on the Differential Calculus' (1852); 'Analytical Statics' (1853); 'Plane Co-ordinate Geometry' (1855); 'Examples of Analytical Geometry of Three Dimensions' (1858); 'Algebra' (1858); 'Trigonometry' (1859); 'The Theory of Equations' (1861); 'History of the Progress of the Calculus of Variations during the 19th Century' (1861); 'History of the Mathematical Theory of Probability from Pascal to Laplace' (1865); 'History of the Mathematical Theories of Attraction from Newton to Laplace' (1873); 'The Conflict of Studies' (1873); 'Laplace's Functions' (1875); 'History of the Theory of Elasticity' (ed. Karl Pearson 1886).

TODHUNTER, John, Irish poet and dramatist: b. Dublin, 30 Dec. 1839. He was educated at Trinity College, Dublin, and after studying at Vienna and Paris, practised medicine for some years in his native city. He was professor of English literature at Alexandria College, Dublin, 1870–74, and later removed to London. He has published among other works 'Laurella and Other Poems' (1876); 'Alcestis' (1879); 'A Study of Shelley' (1880); 'The Banshee and Other Poems' (1888); and several plays, such as 'Helena in Troas' (performed 1886); 'The Prison Flower' (performed 1891); 'A Comedy of Sighs' (performed 1894).

TODLEBEN, tŏt'lā-bĕn, or **TOTLEBEN, Franz Eduard Ivanovitch,** COUNT, Russian general: b. Mitau, Courland, 20 May 1818; d. Soden, Germany, 1 July 1884. He studied at the College of Engineers at Saint Petersburg, and entered the Russian army during its operations against the Circassians in 1848. Having been recognized as a most able engineer in this campaign, he was sent to the Crimea in 1854, where he distinguished himself while under constant fire from the guns of the enemy in the rapid conversion of the city of Sevastopol into a formidable fortress. For this and other valuable service during the Sevastopol campaign he was promoted to the rank of general. At the close of the Crimean War he retired to private life, where he devoted himself to scientific investigation and to the writing of a history of the war. During the Russo-Turkish War of 1877 he was sent to Plevna, where he compelled the commander, Osman Pasha, to surrender his entire army to the Russians. He was afterward made commander-in-chief of the army at Constantinople. At the end of the Russo-Turkish War he entered political life, and was in his later years governor, first of Odessa, and afterward of the province of Vilna. He published an account of the defense of Sevastopol (French trans., 'Défense de Sevastopol,' (1804). Consult Kinglake, 'The Invasion of the Crimea' (1863–87); Brialmont, 'Le général comte Todleben' (1884); Krahmer, 'General-adjutant Graf Todleben' (1888).

TODMORDEN, tŏd-môr'dĕn, England, a town in Lancashire and Yorkshire, on the Calder, 21 miles northeast of Manchester. The churches of various denominations, town-hall, free library, technical school, etc., are the chief buildings. The industries consist of foundries, machine works and manufactories for cotton goods. Pop. about 26,000.

TODY, a term applied to a family (*Todidæ*) of birds closely related to the motmots and kingfishers. They are distinguished by the long flat bill, short and rounded wings and short and square tail. Only four species are known, all of small size, and inhabitants of tropical America. The green tody (*Todus viridis*) of Jamaica is about four inches in length, and green on the upper parts, the flanks rose-colored, the throat scarlet and the belly pale yellow. The bill is red. It frequents the trees along watercourses, and has the habits of a fly-catcher, taking short flights in pursuit of insects and returning to the perch. They nest in the manner of kingfishers, in holes excavated in banks, and lay three or four white nearly spherical eggs. Consult Evans, 'Birds' (New York 1900).

TOFT, an old English word denoting a thicket of trees, a homestead or a piece of ground on which a messuage or home formerly stood. Taken in the second sense toft was frequently used in legal papers in conjunction with the work croft, "toft and croft" meaning a house and homestead, with the stables and outbuildings, the whole surrounded by a thicket or enclosure. Probably from the fact that the house was usually surrounded by trees came the later meaning of soft, which is preserved in the modern word tuft, a grove of trees.

TOGA. See COSTUME.

TOGO, Heihaichiro, COUNT, Japanese admiral: b. Kagoshima, Japan, 1847. He very early became known as one of Japan's most daring naval officers, and a few years before the annexation of the Hawaiian Islands by the United States, he was sent to Hawaii in command of the battleship *Naniwa* to protect the Japanese who were then complaining of persecution by the government. There he nearly became involved in warfare with United States ship *Boston* whose captain supported the demand of the Hawaiian government for the surrender of an escaped Japanese prisoner, and threatened to fire upon the *Naniwa*. When Togo immediately cleared his ship for action, however, the captain of the *Boston* apologized and withdrew his threat. In 1894 Togo practically began the war with China by firing upon Chinese transports carrying troops with an evidently hostile purpose. On the breaking out of the Russo-Japanese War in 1904 he was appointed commander-in-chief of the Japanese navy and conducted the operations against Port Arthur, and the bombardment of that port, defeated the Russian fleet there, driving it back, after severe fighting, to the shelter of the inner harbor, and damaging several Russian ships. On 27–28 May 1905 he met and annihilated the Russian Baltic squadron, only four small cruisers and some torpedo boats escap-

ADMIRAL TOGO

ADMIRAL TOGO

ing. See JAPAN-RUSSO-JAPANESE WAR; MANCHURIA.

TOGOLAND, Africa, a territory on the Gulf of Guinea, between French Dahomey and the British Gold Coast, held as a German colony from 1884 to 7 Aug. 1914, when it was occupied by British and French allied troops. The revenue to Germany in 1913 was over $1,000,000. It has a coast line of 32 miles, but extends 325 miles inland, where it becomes broader. Area, 33,630 square miles. Lome is the chief port and capital. The coast is low and bordered by lagoons, but the interior is crossed by the escarpment of the Sudan Plateau. The country is well watered, the interior by branches of the Volta, which forms the west boundary. The chief products are palm oil, copra, rubber, indigo and dye-woods. Cattle raising is carried on by many of the natives. They also do weaving, make pottery and mine and work a little iron. The inhabitants, who number about 2,000,000, are Sudan negroes, the European population being less than 400. Commerce is rapidly increasing, and there is regular steamship connection with Europe.

TOGUE, a local name in Maine for the lake-trout (q.v.).

TOILERS OF THE SEA ('Les Travailleurs de la Mer'), a novel by Victor Hugo, published in 1866. The scene is laid in the Channel Islands and the book is dedicated to the "Isle of Guernsey, severe yet gentle, my present asylum, my probable tomb."

TOISE, toiz, in the French system of measures used previous to the decimal system, was the unit of linear dimension. It consisted of six pieds or feet, each of which was composed of 12 pouces or inches, each pouce being divided into 12 lignes or lines. The toise was thus the equivalent of 1.94904 + metres or of 6.3946 + English feet.

TOKAT, tō-kät', Asia Minor, a town in the vilayet of Sivas, 70 miles from the Black Sea. It extends between steep rocky walls in a labyrinth of narrow streets bordered by miserable houses. It contains a large mosque, bazaars, foundries and manufactories of carpets, silk, wool and cotton goods, etc. Copper is mined in the vicinity. The town was formerly prosperous, but ill treatment of the Armenian population has largely reduced its inhabitants, believed to number about 22,000 in 1919.

TOKAY, tō-kā' (Hungarian, tō'koi), Hungary, in Semplin County, at the junction of the Theiss and Bodrog, 130 miles northeast of Pesth. Its buildings include a theological seminary, gymnasium, high school, etc. In the neighborhood are rich mineral deposits, as salt, sapphires, etc. The chief occupations are agriculture, fishing, viticulture and timber-trade. The Tokay wine is famous and the best is produced on the hill of Mezés-Máli. Great care is exercised in the culture, gathering and selection of the grapes. The wine is of various qualities, dependent finally upon the amount or lack of artificial pressure. The best kinds are the *Essence* and the *Ausbruch*, of amber color when new, turning green with age. There are 34 wines, grouped as sweet and dry; 2,000,000 gallons are produced, but the celebrity of the wine is such that many imitations are made by French and German dealers, which are even sold in Hungary. Pop. 5,500.

TOKEN MONEY, a name in numismatics applied to pieces of money current only by sufferance and not coined by the authority of the state or government. In England in the 16th century the national coinage was so unsatisfactory and inconvenient that large numbers of private traders and merchants were impelled to have halfpence and farthings manufactured for themselves. These "tokens," as they were called, were made of lead, pewter, latten, tin and even leather, and could only be made use of as currency at the shops or warehouses of their respective issuers. Notwithstanding the endeavors made during several reigns to put a stop to the circulation of this unauthorized coinage, traders' tokens continued to multiply to an astonishing extent, until, in 1672, a proclamation was issued, prohibiting their making or use under severe penalties. From that date until 1787 the issue of private tokens entirely ceased; but in the latter year, owing to the great scarcity of government copper coins, the Anglesey Copper Mines Company struck and put into circulation some 300 tons of copper pence and halfpence. The bold example thus set was speedily followed by other trading firms all over the kingdom, and again the government found it necessary to take action in the matter, which it did by issuing a new national copper coinage. For some years the issue of private tokens was thus effectually checked; but in 1811 the authorized coinage again getting scarce, the copper companies and others recommenced the issue of batches of tokens. This went on until 27 July 1817, when the manufacture was prohibited by act of Parliament, and all tokens in currency ordered to be withdrawn from circulation by 1 Jan. 1818.

In the United States small coins became so scarce in 1862 that tokens made their appearance in large quantities. They were of two classes, war or patriotic tokens, and trade or advertisement tokens. Both kinds were issued with a mercantile view, since they passed for a cent and could be manufactured (in sufficient quantities) for much less. Cards and tokens appeared during 1862, 1863 and 1864. Of the patriotic or war tokens there were something like 400 varieties coined, including mulings and different metals, the latter largely restrikes. Of original pairs of obverse and reverse there must have been less than 200. The common varieties bore the inscriptions "Army and Navy," and "Not One Cent." The first coinage of trade tokens, or store cards, as they were sometimes called, took place in Cincinnati where nearly 900 varieties were issued, fully three times as many varieties as any other city issued except New York. A number of other Western cities soon followed the example of Cincinnati, but it was not until the early part of 1863 that New York began to issue the famous Lindenmuller cents, of which there were more than a million coined; these were followed by the Knickerbocker tokens, consisting of many varieties. Altogether there were between 600 and 700 varieties issued from New York. Ohio issued about 1,300 varieties from 100 different cities and towns, more than any other State issued; New York State comes next after Ohio, with over 900 varieties. New Jersey had but few, and Pennsylvania not many; chiefly from Philadelphia and Pittsburgh. Detroit furnished as many advertisers as New York, and the rest of Michigan nearly as many as Cincinnati. Indiana had about 100; Illinois, including Chicago, not as many as Indiana; and Wisconsin nearly twice as many. When the government stopped the coinage of tokens in 1864 there were upward of 20,000,000 in circulation.

TOKIO, tō'kē-ō, or **TOKYO,** the capital of Japan, situated at the head of the land-locked Bay of Tokio, on the east coast of central Hondo, and at the mouth of the Sumida Gawa. Besides the latter river, which divides the city into two unequal parts, Tokio is intersected by a large number of canals, which are generally crossed by wooden bridges. Some of the canals form concentric courses, enclosing a number of islands, one within the other; and on the innermost of these stands the imperial palace. This large cluster of buildings is surrounded by magnificent gardens, and enclosed by high walls and fosses. On the outer islands are most of the government departments and foreign legations. Surrounding these central islands, the city spreads out on all sides, with a rather irregular and complex street plan. There are numerous parks in and around the city, some of them being large and beautiful. Practically all the houses are built of wood. Besides the palace the only notable buildings are some of the numerous temples, especially that of Kwannon, and the temple of the Shoguns. There are six European churches, the finest being the Russian cathedral. Tokio contains about 70 hospitals of good standing, including the Komagome Hospital for epidemics and the Tokio Charity Hospital. The former is supported by the city and the latter by the Imperial Court. There also exists an asylum for orphans of the poor, established by the city. According to the latest returns on educational affairs there are about 500 public and private primary schools and kindergartens. The number of children of school age is about 225,000 of whom about 80 per cent are in attendance. There are 35 middle schools, public and private, of which six are for girls. The schools higher than middle grade and placed under the direct control of the Department of Education number 13, including the Imperial University, the First High School, the Higher Commercial School, School of Foreign Languages, the Tokio Higher Technical School, Higher Male Normal School and Higher Female Normal School. Besides there are two public normal schools, supported by the Tokio Prefecture. The keiogijiku, Waseda and Women's University are most prominent among the private high class institutions, among which are included 10 other colleges of law, economics, philosophy and religion. In addition to those above mentioned, there are over 280 public and private schools, mostly of the middle school grade, teaching special subjects. The city has a number of libraries opened to the public, including the Imperial Library at Uyeno Park. The sanitary condition of the city is in a fair condition, though street drainage is not so well advanced as in Western countries. Each *ku* (ward) has sanitary organization supported by rate levies from the inhabitants themselves. The metropolis is well supplied with parks and open spaces. The largest parks are the Shiba, Uyeno and Hibiya parks. In the first two are beautiful temples connected with the old Tokugawa family, and here the remains of the Shoguns are buried. At Uyeno also is the Imperial Museum. Automobiles have been introduced as a means of transportation and an «autobus» line is in operation, in addition to the electric tramways. Streets are being laid out regularly of late years and modern dwellings are being erected. Great harbor works have been undertaken by the municipal assembly at a cost of 37,000,000 yen. There are also a modern water-supply system, excellent street railways, gas and electric light, macadamized roads, public works, etc., all carried on according to methods of civilized cities all over the world. The municipal council is elected by the municipal assembly, and the latter is chosen by popular vote. Although the principal railroad centre of the empire, Tokio is not an important manufacturing or commercial city. Its port is Yokohama, near the entrance to the bay. The city was founded in 1456 and in 1590 it became the capital of the Shoguns, the emperors residing at Kioto. With the downfall of the Shoguns in 1868, Tokio (till then known as Yedo) became the residence of the emperors and the sole capital. It has several times suffered from earthquakes and conflagrations. Pop. 2,244,796.

TÖKÖLY, tė'kėl-yĭ, or **TÖKELY, Emerich,** COUNT, Hungarian patriot. See TEKELI.

TOKUGAWA, PRINCE, Japanese nobleman and political leader, known as «the last of the Tycoons.» See HITOTSUBASHI.

TOKUSHIMA, tō-koo-shē'mạ, Japan, the capital of the prefecture of the same name, and the largest city on the island of Shikoku, situated on the northeast coast, on the Kü Channel. It is an important steamship station, with a picturesque location on the coast and a mountainous background. Pop. 70,000. The prefecture population is 775,000.

TOLAND, John, English writer: b. near Londonderry, 30 Nov. 1670; d. Putney, 11 March 1722. He was brought up as a Roman Catholic, but at 16 went over to Protestantism. He was educated at the University of Glasgow, and studied divinity in the University of Leyden. In 1696 he published a work entitled 'Christianity not Mysterious,' which may be regarded as opening the prolonged English controversy between deism and orthodoxy. The House of Commons ordered it to be burnt by the common hangman, and Toland met with determined opposition from many quarters, though Locke gave him a certain amount of support. He subsequently supported himself by literary hack-work and various forms of political party service. Besides the work above mentioned he wrote a 'Life of Milton' (1698), in an edition of his prose works; 'Memoirs of Denzil, Lord Holles' (1699); 'Anglia Libera' (1701), a defense of the Act of Succession, and 'The State Anatomy of Great Britain,' etc. (1717).

TOLEDO, tō-lē'dō, Iowa, city, county-seat of Tama County, on the Chicago Northwestern Railroad, about 50 miles northeast of Cedar Rapids and three miles from Tama (q.v.), a railroad junction on the Iowa River. It was settled in 1844. It is in a fertile agricultural region in which there is considerable attention given to stock-raising. The industries are connected chiefly with the farm products. The principal public buildings are the county courthouse, jail, the churches and schools. The educational institutions are Leander Clark College (U.B.), opened in 1856; a Government Indian Industrial School, public schools, and a library. There are two banks and two newspapers besides a collegiate weekly. The government is administered by a mayor and a council composed of six members. Pop. 1,721.

TOLEDO, Ohio, city, county-seat of Lucas County, on the Maumee River, near its mouth; lat. 41° 30′ N., long. 83° 32′ W. The city is 587 feet above sea-level. It is 96 miles west of Cleveland, 124 miles north of Columbus and 234 miles east of Chicago. The northern corporation line is within two miles of the Michigan boundary. The city lies on both sides of the Maumee River, the principal business section being on the left bank; it extends from the river mouth, where the stream opens into Maumee Bay, to a point nine miles up stream. The area of the city is 31.59 square miles.

Commerce and Transportation.— The location of Toledo, at the western end of Lake Erie, gives it great commercial advantages, for it is at the head of the direct lake route eastward. The distance by lake to Chicago is 691 miles, while it is but 234 miles by rail. Hence there is an enormous traffic between the Eastern cities and the region lying southwestward, of which Toledo is the distributing point. This natural advantage is supplemented by the railway system, the city being the centre of 16 trunk lines, making direct communication to the Atlantic on the east and the Pacific on the west, with direct lines north and south. These trunk lines, including their branches, give a grand total of 23, making Toledo second only to Chicago in the number of railroads; 393 trains and 572 interurbans arrive and depart every 24 hours. Many of the trunk roads reaching the city have dock facilities, with regular steamer connections to all important lake ports. The location of Toledo makes it the most convenient shipping point for a large portion of the "winter-wheat belt," and it is one of the most important primary grain markets of the United States, after Chicago. It has 12 grain elevators, with a storage capacity of 8,500,000 bushels. Toledo is the leading clover-seed market of the world and its quotations govern the prices of clover-seed for the United States. In 1918 Toledo received over 20,000,000 bushels of wheat, corn, rye, oats and barley. Toledo is one of the largest shipping ports for soft coal in the world. This comes by rail from the mines of West Virginia, southern and eastern Ohio and Pennsylvania, and is transported by water to all ports on the upper lakes. The Ohio Central, Hocking Valley, Pennsylvania and Baltimore and Ohio railroads have immense docks on the river front, with steam apparatus by which a carload of coal at a time is conveyed into the hold of a vessel. Similar appliances are used for the rapid unloading of iron ore coming from the Lake Superior mines, which is shipped by the same roads to the iron furnaces in southern Ohio, to mix with the native ores, thus producing a superior quality of iron and steel. There is also a very large trade done in lumber, salt, etc., Toledo being the largest distributing point on the lakes for coal, ore and lumber. More than 50 per cent of all the coal transported on the Great Lakes in 1918 was loaded in Toledo.

The harbor of Toledo lies entirely within the Maumee River, giving full protection to shipping. The Maumee is really a wide and deep estuary of Lake Erie, to the foot of the historic "Rapids of the Maumee," just above Perrysburg, the site of Fort Meigs, famed for Harrison's defense in 1813. Above this the river passes for some 15 miles over outcrops of limestone. At the northern city line the river opens into Maumee Bay, which is three miles north and south by six miles east and west. Through the bay the United States government has dredged a straight channel, 400 feet wide by 21 feet deep and eight miles long from the mouth of the river. The harbor proper embraces the wide channel of the river, which is 700 to 1,400 feet wide between the harbor lines established by the government. The channel of the stream has been improved by the government to the same depth and width as the straight channel. The cost of this channel through the bay, and the corresponding river improvements, has been over $2,000,000. The wharfage space covers both banks of the river the entire length of the city, 18 miles in all, besides several miles on Swan Creek, a deep tributary which enters the river in the middle of the business section. Besides these there is unlimited wharf capacity along the shores of the bay, now being utilized.

Manufactures.— The advantages of Toledo as a distributing point by lake and rail, its proximity to raw material and fuel, have caused its industrial interests to dominate all others. As an example of this is the fact that the renowned Lake Superior iron ores and the coal and coke from the Ohio and West Virginia fields meet at its wharves on a common basis of economy. This resulted in the building in 1903 and 1904 of a blast furnace and steel plant on the river front by the Toledo Furnace Company with a capacity of 400 tons per day. This company is now capitalized at $4,000,000 and its capacity has been doubled. Other great industrial establishments nationally known and with large capital invested in Toledo are the Willys-Overland Company, $75,000,000, producing passenger automobiles. This is the second largest automobile plant in the world; the Paragon Refining Company, $25,000,000, which refines petroleum; the Owens Bottle Machine Company, $15,500,000, producers of the bottle-making machine, which has revolutionized that industry; National Supply Company, $14,000,000, producing oil well supplies and machinery; the Electric Auto-Lite Company, $13,000,000, producing automobile starting and lighting systems; the National Malleable Castings Company, $8,000,000, with the largest malleable casting plant in the world; the Sun Company, $5,000,000, refiners of petroleum products; the Toledo Machine and Tool Company, $3,000,000, builders of presses and machine tools; the Towar Textile Mills Corporation, $2,500,000, producing heavy ducking and belting; the Champion Spark Plug Company, $2,000,000, which produces more than 50 per cent of all the spark plugs in the world;

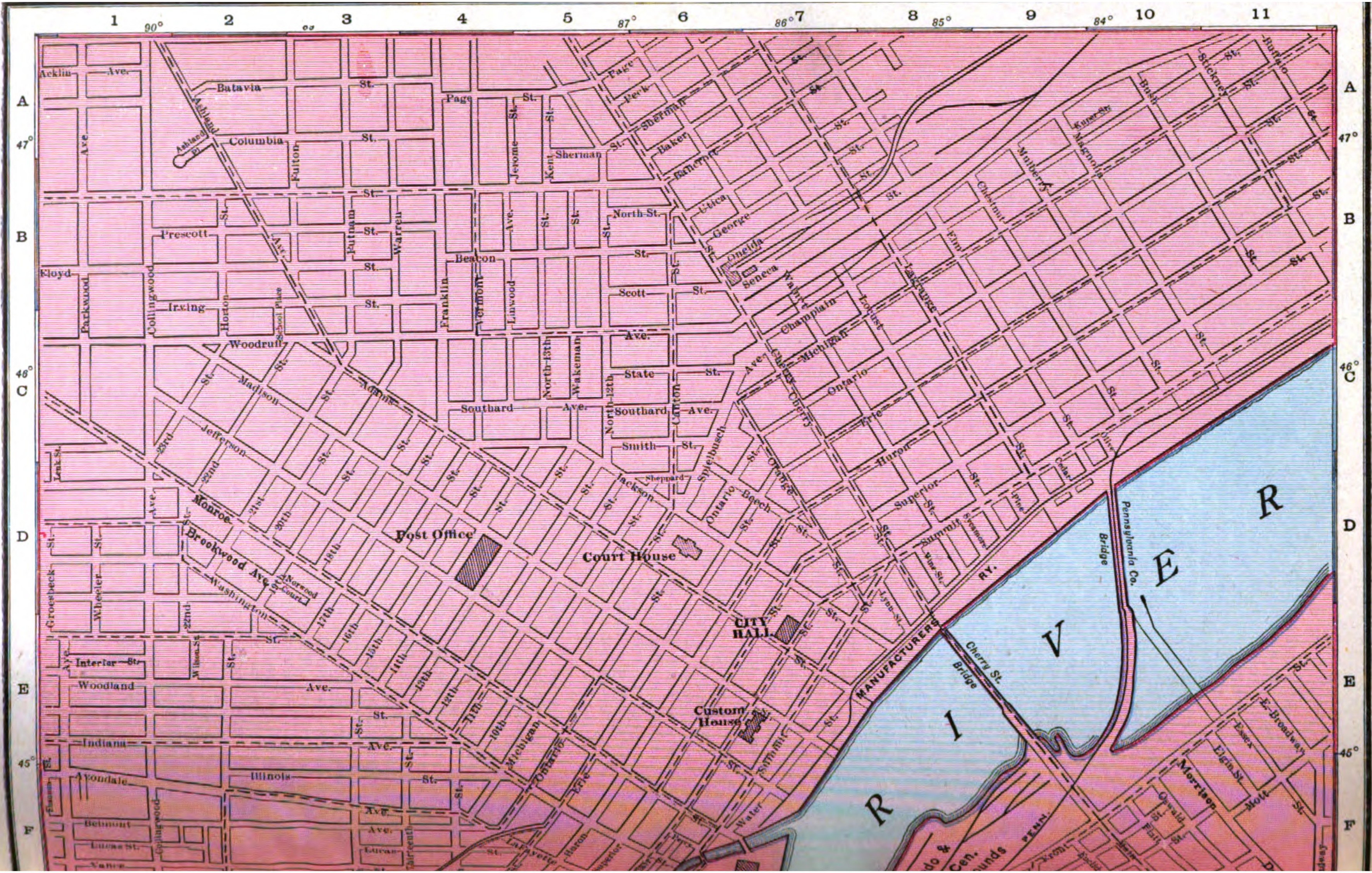
the Ed. Ford Plate Glass Company, $2,000,000, manufacturers of polished plate glass; the Toledo Shipbuilding Company, $2,000,000, which has built some of the largest ships on the Great Lakes; the Libbey Glass Company, $1,000,000, manufacturers of fine cut glassware and electric light bulbs; the Hettrick Manufacturing Company, $1,000,000, manufacturers of tents, awnings and canvas goods; the Toledo Sugar Company, $1,000,000, which refines sugar from beets extensively cultivated in the territory surrounding Toledo; the Toledo Scale Company, $900,000, manufacturers of the famous Toledo scale; Milburn Wagon Company, $700,000, builders of farm wagons and electric vehicles. There are more than 600 other busy manufacturing plants in Toledo; in the Manufacturing Directory, issued by the Toledo Commerce Club, there are 921 different classifications of articles made in Toledo. Toledo is the centre of the metal wheel industry in the United States. There are four plants in Toledo capitalized at $1,250,000, producing bicycles and children's vehicles and giving employment to more than 1,000 men. More than 60,000 people are employed in the industries of Toledo. Most of the power used in the factories is supplied by the Toledo Railways and Light Company. The Acme Power Company, a subsidiary company of the Railways and Light Company, has completed the first unit of an $8,000,000 plant, which will be utilized to further electrify Toledo's industries. The Standard Oil Company of Ohio has erected a $5,000,000 refinery. This company has a pipe line direct to the mid-contenent field, through which the crude oil is pumped. The $20,000,000 nitrate plant started by the government in 1918 in Toledo is to be converted into a permanent arsenal. Toledo is one of the busiest wholesaling and jobbing centres in the Middle West. The many railroads and electric lines make shipping easy to any territory surrounding the city. Post office records show that 42,000,000 people can be reached with over-night mail service. Large manufacturers in the East and West maintain branch houses and distributing stations in Toledo.

Banks.— There are four national banks and 18 State savings and private banks in Toledo. The capital of the national banks is $3,500,000, and the surplus and undivided profits of these banks amount to $4,499,382. The capital of the other 18 banking institutions totals $4,140,300, with surplus and undivided profits of $2,366,619. In addition to these banks there are eight building and loan companies with a combined capital stock of $26,700,000. At the beginning of 1918 the bank deposits in Toledo passed the $100,000,000 mark; clearings during 1918 totaled $539,114,586. Toledo also is the home of nine bond houses, which do a business upwards of $85,000,000 annually. In 1918 Toledo lead all cities of its class in postal savings deposits. Records show there were 2,950 individual depositors and $1,318,173 on deposit. The post-office receipts in Toledo in 1918 totaled $1,391,000.

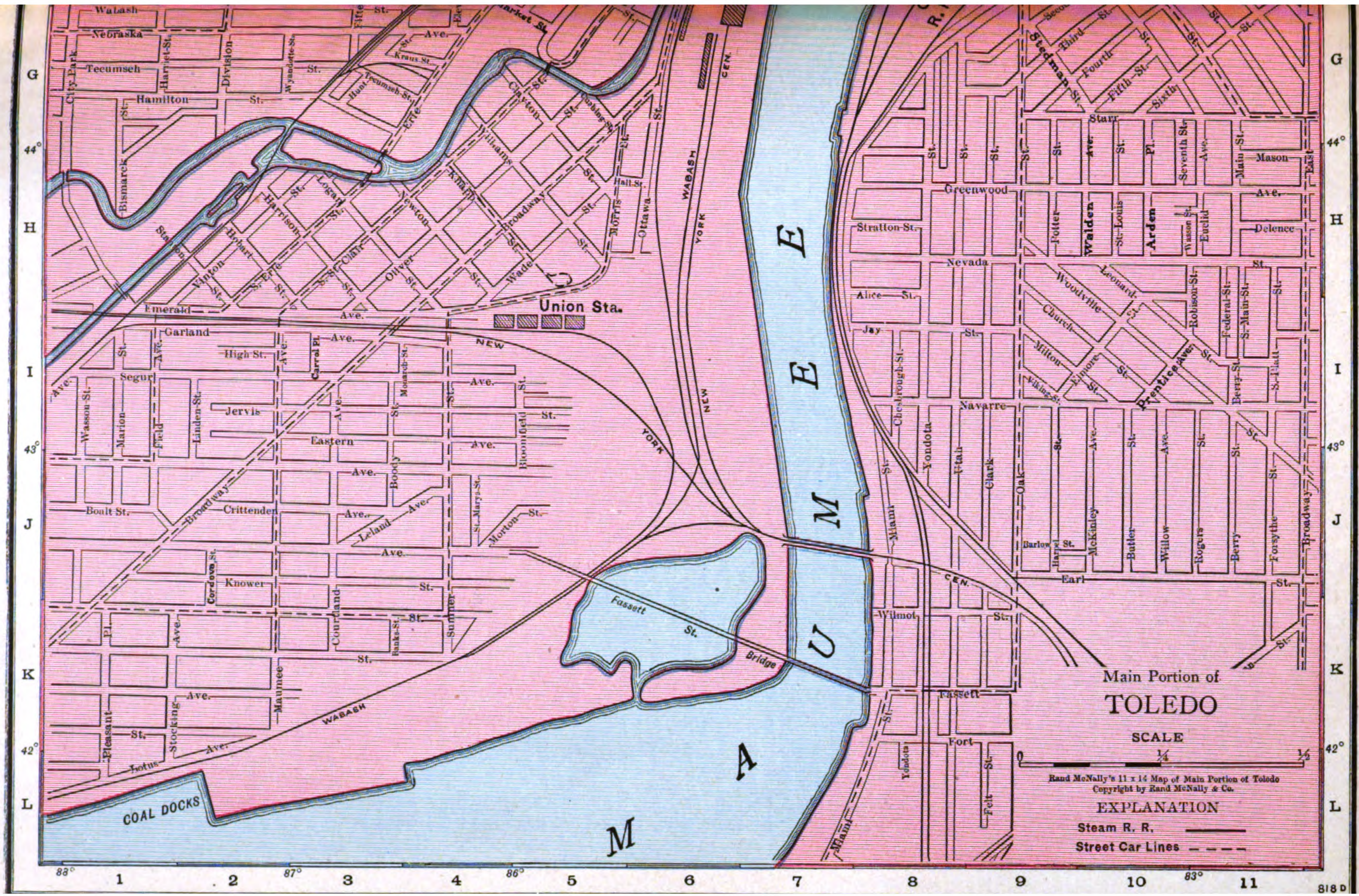
Municipal Conditions.— The slope from the river on both sides is gradual, but amply sufficient to ensure good drainage. It is well laid out, with wide streets. These aggregate 423 miles in length, of which 400 miles are sidewalked, 256 miles electrically lighted and 244 miles are paved, chiefly with wood block, brick and asphalt. The residence streets are beautifully shaded, and the absence of all fencing gives this section a park-like appearance. The sewerage system is excellent, there being a total of 292 miles, all emptying into the Maumee River. The waterworks originally cost about $1,400,000 and has a capacity of 70,000,000 gallons daily, with 353 miles of street mains. The city is supplied with natural gas brought from three fields, northwestern Ohio, central Ohio and West Virginia; and there are 25,000 consumers, the gas being used only for household purposes. The electric car system is very complete, covering 120 miles of streets and accommodating all sections of the city. There are 10 distinct interurban electric roads in addition, with freight and passenger stations in the business centre. They have a total of 1,546 miles of track, connecting Toledo with a large number of surrounding cities and villages, including Cleveland and Detroit. The discovery of gas and petroleum in northwestern Ohio in 1887 was one of the contributing causes for the growth of Toledo, as this city is the natural metropolis in the oil area and this business still remains a potent factor. The rapid growth in population caused the expansion of the residence section in Toledo. In the west end of the city, which is the newer area, there are thousands of beautiful homes set among the original forest trees. In more recent years beautiful residential sections have been developed by real estate operators. Ottawa Hills is one of the most beautiful high-class residential developments in the country. Many large homes have been built in the up-river section. Toledo has a greater per cent of home-owners than any city of its size in the country. The working man owns his modest home and takes a pride in his lawns and garden patch. All of the residential streets are well paved and lighted with 3,160 arc lamps.

Buildings.—Among the notable buildings are the courthouse, in front of which is a fine bronze statue of President McKinley, erected in 1903; Museum of Art; the Young Men's Christian Association building; the Masonic temple; the Young Woman's Christian Association building; Newsboys' building; the City Market; the Terminal Auditorium, which will seat 5,000 persons; handsome Toledo Club building; Woman's building; a Soldiers' Memorial building; armory of the Ohio National Guard; the Public Library (which has 50,000 volumes and five sub-stations); the Valentine Theatre, one of the finest and most artistic interiors in the United States, and many modern office and business blocks.

Churches and Schools.— There are 91 church edifices in the city, nearly all having Sunday-schools. Some of the rooms devoted to the latter are up to the best modern standards in plan and equipment. Nearly all have large libraries for the use of the scholars. There are two public high schools, built at a cost of $750,000 each, a manual training school and a vocational high school. There are 51 public school buildings, besides 22 parochial schools belonging to and controlled by the Roman Catholic Church. The latter Church also supports an academy under the Ursuline Nuns,



RIVER
Pennsylvania Co. Bridge
Cherry St. Bridge
MANUFACTURERS RY.
Post Office
Court House
CITY HALL
Custom House
Batavia
Columbia
Ashland
Prescott
Lloyd
Parkwood
Collingwood
Irving
Horton
Woodruff
Madison
Jefferson
Adams
Monroe
Brookwood Ave.
Washington
Franklin
Vermont
Beacon
Warren
Putnam
Fulton
Page
Jerome
Kent
Sherman
North St.
Scott
State
Southard
Smith
Canton
Spielbusch
Jackson
Ontario
Beech
Orange
Cherry
Champlain
Michigan
Erie
Huron
Superior
Summit
Water
Lagrange
Locust
Chestnut
Mulberry
Magnolia
Bush
Stickney
Buffalo
George
Oneida
Seneca
Baker
Perry
Utica
Woodland
Indiana
Illinois
Avondale
Belmont
Lucas St.
Interior St.
Wheeler
Groesbeck
Acklin
Morrison
E. Broadway
Essex
Elgin St.
Mott


Main Portion of
TOLEDO
SCALE
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Rand McNally's 11 x 14 Map of Main Portion of Toledo
Copyright by Rand McNally & Co.
EXPLANATION
Steam R. R.
Street Car Lines
MAUMEE
COAL DOCKS
Union Sta.
Fassett St. Bridge
WABASH
NEW YORK CEN.
Greenwood
Stratton St.
Nevada
Navarre
Yondota
Utah
Clark
Oak
Earl
Walden
Arden
Prentice Ave.
Woodville
Church
Milton
Leonard
Broadway
Forsythe
Emerald
Garland
High St.
Jervis
Eastern
Crittenden
Knower
Maumee
Stocking
Pleasant
Lotus
Wasson St.
Marion
Segur
Wabash
Nebraska
Tecumseh
Hamilton
Bismarck
Division
Erie
Williams
Knapp
Newton
Oliver
Wade
Ottawa
Morris
Sumner
Courtland
Boody
Bloomfield
Fort
Fassett
Wilmot
Miami
Starr
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86°
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818 D

a similar school by the Notre Dame Sisters, and Saint John's College, an institution for boys and young men, under the direction of the Order of Jesuits. Toledo University with an enrolment of 1,200 students is maintained by the city. There are 10 private schools; two large business colleges, one of which has 500 students. The Museum of Art is an organization for the advancement of art, numbering in its membership the most progressive citizens. It occupies a building built at a cost of $1,000,000 and a valuable gallery of paintings and objects of art.

Charities.—Among the benevolent and philanthropic institutions are the Toledo State Hospital for the Insane, supported by the State. This is an institution on the cottage plan, with accommodations for 1,700 inmates; the Toledo Hospital, a large institution supported by the voluntary contributions of citizens; Saint Vincent's Hospital and Saint Anthony's Orphans' Home, conducted by the Gray Nuns; Lutheran Orphans' Home; Old Ladies' Home; a Roman Catholic hospital for the aged, conducted by the Little Sisters of the Poor; Mercy Hospital; Robinwood Hospital; Flower Hospital; Maternity Hospital; the Country Children's Home; the Young Men's Christian Association and Young Woman's Christian Association; the day nursery, a home for foundlings, training school for nurses and a number of private hospitals.

Parks.— The park system of Toledo em braces a total of 1,532 acres; beginning at the city limits up the river on the west side is Walbridge Park, 64 acres, on a bluff 75 feet high, with an unrivaled river view; Ottawa Park, on the western side of the city, 280 acres; Willys Park, 100 acres; Bay View Park, 202 acres, at the point where the river empties into the bay. Further up the river on this side is Riverside Park, 63 acres, fronting the stream. On the east side are Collins Park, 90 acres, and Navarre Park, 62 acres. Besides these, there are 44 smaller parks and triangular spaces, ranging from one-eighth of an acre to seven acres area. The large parks are connected by a boulevard, which is 10 miles long on the west side, 150 to 200 feet wide, now under construction, extending in a semi-circle from Walbridge to Bay View parks, the most of the necessary land being donated by property-owners. On the east side a similar semi-circle is projected and partially completed. Recreation centres and parks are being increased in number as rapidly as the city budget permits.

Recreation.— Toledo offers all the advantages of a summer resort, because of its proximity to Lake Erie and its fine beaches. Just 45 minutes from the heart of the city is located Toledo Beach. Here will be found many comfortable summer homes along the edge of Lake Erie, extending for a distance of several miles. Hundreds of Toledo people spend the summer months at the beach, going to and from work each day. The street car company maintains a half-hour service to this resort. Point Place and Edgewater, located on the bay just outside the city limits, are meccas for fishermen. On the south shore of Maumee Bay will be found Harbor View Beach, with many cozy summer homes nestled among the groves which border the bay shore. In the city Walbridge, Riverside and Bay View parks are located on the banks of the Maumee River. These are easy of access and daily, during the summer time, attract thousands of people. Yachting and canoeing are favorite sports in Toledo. The river and bay are dotted with small crafts of all kinds. More than $5,000,000 has been invested by the people of Toledo in sailboats, motorboats, canoes and cruising yachts. There are three yacht clubs and a power boat club. Toledo Yacht Club maintains one of the finest buildings of its kind in the country at the mouth of the Maumee River. This club adjoins Bay View Park. The Toledo Power Boat Club is situated on the bay near Bay View Park. The Maumee River Yacht Club is located at the southerly end of Walbridge Park. The Ottawa River Yacht Club has headquarters on Ottawa River near the bay. The city maintains a municipal club house at Riverside Park. There are many other smaller club houses supported by canoe clubs, etc. In the winter time ice boating and skating are the leading outdoor sports. Practically all of Toledo's parks have public swimming pools and the most modern playgrounds equipped for the children. In Ottawa Park there is one of the finest municipal golf courses in the United States. Public tennis courts also are maintained by the city. Fine golf courses are maintained by the Inverness Club, Country Club, South Shore Country Club and the Sylvania Golf Club. There is a keen interest in Toledo in baseball. Toledo supports a team in the American Association, and Swayne Field, the home of the Toledo team, is one of the finest ball parks in the league. There are many semi-professional teams which have large followings. The city maintains ball diamonds in several of its parks. Toledo is a Mecca for excursions during the summer months; people come for hundreds of miles to take trips on the water. Three passenger steamship lines maintain regular service to Sugar Island, Detroit, Mackinac, Put-in-Bay, Cedar Point, Cleveland, Buffalo and other points on the Great Lakes.

Government.— Toledo has a simplified form of the Federal form of government. The people elect the mayor, vice-mayor and one ward councilman. All other city officers are appointed by the mayor, with the exception of the city clerk, who is elected by council. All city offices are for a term of two years. There are 16 wards. The vice-mayor presides over council, but has no vote except in case of a tie. The mayor's cabinet, appointed by him, consists of the heads of various city departments; these are a director of law, director of public service, director of public safety, director of public welfare, director of finance.

History.— The Maumee River was one of the most important routes for travel by the Indians and the white traders. Going by canoe to a point near Fort Wayne, Ind., a portage of a few miles enabled them to reach the headwaters of the Wabash, which they followed to the Ohio and thence to the Mississippi. Another important route was up the Maumee and the Auglaize, a southern tributary, thence by portage to the headwaters of the Great Miami, which reaches the Ohio just below Cincinnati. An important Indian trail also crossed the river at the rapids above the city, by which hunting parties went to Kentucky. A few French Canadian hunters and trappers settled, in the 18th century, at points within the present site of Toledo; but there is no reliable account of the earliest sporadic settlement of Americans on the city plat. In 1805 a treaty was made between the United States and the Indians, at a stockade, named Fort Necessity, which stood on a high clay bluff at the junction of Swan Creek and the Maumee. By this the red men yielded title to the «Fire Lands,» granted to the citizens of Groton and New London, Conn., in recompense for the burning of these towns by the British in the Revolution. In 1817 a company of speculators laid out a town at the mouth of Swan Creek, called Port Lawrence. Very few settlers came, however, and the hamlet languished. In 1832 another settlement, named Vistula, was begun by Major Stickney, for many years Indian agent, a mile further down the river, at the foot of what is now Lagrange street. This spurred the owners of the land at Port Lawrence to new efforts, and a brisk rivalry sprang up between the two villages. The two were wisely consolidated in 1833. A public meeting of the citizens of both was held to determine the name of the united town; and, at the suggestion of Willard J. Daniels, the name of Toledo was adopted. He had been reading a history of Spain, and urged the name of the old Moorish capital for the reasons that there was no town of that name in America, that it has a pleasant sound and is easily pronounced. Toledo was incorporated as a city in 1846.

The town had slow growth until the opening of the Wabash and Erie Canal, from Toledo to the fertile Wabash Valley in Indiana, in 1843, and of the branch from Defiance south to Cincinnati, called the Miami and Erie Canal, which was opened to traffic in 1845. In 1846 these two canals brought to Toledo products valued at $3,000,000, while those going from Toledo to points on both aggregated nearly $5,000,000. The first railroad to reach Toledo was called the Erie and Kalamazoo, which was opened from Toledo to Adrian, Mich., in 1836, the cars being drawn by horses. The next year a locomotive was put on the line, and a contract for carrying the mails was obtained from the government. The road was sold by the sheriff in 1842, and its line is now part of the great New York Central system.

Population.— The population (1840) was 1,222; (1860) 13,768; (1880) 50,137; (1900) 131,822; (1910) 168,497; (1918) est. 262,000.

RAYMOND T. SKINNER,
Toledo Commerce Club.

TOLEDO (Sp. tō-lā'tho), Philippines, pueblo, province of Cebu, on the west coast, 35 miles west of the pueblo of Cebu. Petroleum and natural gas are reported in the vicinity. Pop. about 13,500.

TOLEDO, Spain, in New Castile, capital of a province of the same name, on the Tagus, 45 miles southwest of Madrid. It is the archiepiscopal see of the primate of Spain. The city is walled and occupies an acclivity, around which rise lofty mountains. The city is built compactly, houses crowded, streets steep, winding and narrow. The chief points of interest are the Alcazar (1551), once including fortress and palace, which occupies a central and high point of the town; the great Gothic cathedral (1227–1493), a most imposing edifice of great architectural merit, which has seen many vicissitudes but retains some fine stained glass and a choir of marvelous beauty. The large square of Zocodoven is the fashionable promenade, and thoroughly Moorish in character. Here the heretics were burned and the bull-fights take place. There are besides a theological seminary, monastery, several palaces and hospitals. The manufactures comprise the famous Toledo sword-blades, small-arms, church ornaments and vestments, silk, wool and cotton textiles and confections. Toledo was the ancient capital of all Spain and important in the country's history. It was taken by the Romans 193 B.C.; and subsequently was occupied in turn by Goths, Moors and Castilian monarchs. It was also the seat of the Inquisition (q.v.). The town is now sadly decadent. The Alcazar, so often damaged by fire, has been restored with considerable expense. Pop. about 22,000. The province has an area of 5,919 square miles and a population about 438,071. Consult Calvert, A. F., 'Toledo: an Historical and Descriptive Account' (New York 1910).

TOLEDO NEWSBOYS' ASSOCIATION, The, was organized 1892, with its founder, John E. Gunckel (q.v.), as president. Mr. Gunckel remained president of the association until his death in 1915. Through his untiring efforts the association had a marvelous growth and was the means of reclaiming the heretofore neglected boy and girl and remolding their lives, making them useful and substantial citizens, capable of carrying on and furthering the plans of the great metropolis, which, like all cities, must be trusted to a rising generation. To-day former newsboys of this association are filling and in many instances managing the great business enterprises of the city. Following his death, Mr. J. D. Robinson, one of Toledo's greatest philanthropists, became its president, and again the association was placed on a solid foundation. Never in the history of the association has it enjoyed greater prosperity. The association as in the past is loyally supported by the philanthropic people of the city, and every advantage is offered the boy of the street to become a useful and honored citizen. The boys are constantly warned of the evils and dangers that beset them and urged to refrain from gambling, stealing, lying, swearing, smoking cigarettes, drinking intoxicating liquors, going into saloons or associating in bad company. A fine brick building built in 1908, costing $110,000, dedicated to the newsboys of Toledo, furnishes them one of the finest auditoriums in the city together with a spacious and well-equipped gymnasium and cadet room, swimming pool of large capacity, fine library, playrooms, furnished kitchen and dining-room, lobbies and special rooms for band and orchestra practice, where the association maintains a 36-piece band and 14-piece orchestra. The association now has a membership of 11,500. Sunday afternoon entertainments, a special feature of the association, from 1 October to 31 March, given by the schools, churches and different organizations of the city, are highly appreciated by the boys. Each Sunday the auditorium is filled to its capacity. The association also maintains a court of investigation, where erring boys are required to account for misconduct. An employment bureau within the association proves a valuable asset and many boys are placed in responsible positions, later to become

TOLEDO

1 General Post Office

2 Scott High School

partners or managers. The boys are encouraged to return all found articles to the building. Articles of more than $50,000 have been returned to their rightful owners, for which the finder receives an «honor» badge. Each year the entire association is tendered an outing, or better known «Field day,» which never fails to add a bright page to the history of the newsboy.

TOLEDO WAR, The, a name popularly given to the contest over the division line between Michigan on the north and Indiana and Ohio on the south. It arose out of an error in the location of the southern point of Lake Michigan. In 1805 the Territory of Michigan was organized in conformity with the Ordinance of 1787, which provided that the line between Ohio, Indiana and Illinois on the south, and the territory on the north, should be «an east and west line running through the southern point of Lake Michigan.» This was set down on the maps of the times 42° 32′ N., but when Michigan was organized it was found that the true line through the southern point of Lake Michigan was 65 miles to the south, or 41° 37′ 19″ N., and this more southerly line was adopted. But when Indiana and Illinois were organized as States, the northern line was adopted, and there was thus left a belt 65 miles broad claimed by both factions. Congress ordered a survey, which was completed in 1817, establishing the «Harris» line, near the northern one. But the people of Michigan protested vehemently, as the city of Toledo was in the disputed belt. In 1836 Ohio by act of legislature organized townships in this territory, which had long been under the control of Michigan. Then both Michigan and Ohio appealed to President Jackson, but got no relief. The governor of Ohio called out the militia, the governor of Michigan did likewise and occupied Toledo. When it seemed as if a conflict could no longer be prevented the matter was settled by the admission of Michigan to the Union as a State upon condition of her acceptance of the «Harris» line, and giving her in recompense the northern part of the peninsula of Wisconsin. Great deposits of copper and iron being found in this peninsula, Michigan accepted the conditions and entered the Union as a State 26 Jan. 1837. See United States, the Wars of the.

TOLERATION, a word meaning in its general sense forebearance without approval, as when a state has an established church, but other churches are tolerated — that is, their members are permitted to worship in their own way without interference on the part of the state. In this meaning toleration is different from the system of voluntary support of all churches without a state religion. It was much used in America, however, in a narrower, or perhaps a broader, sense, during the struggle to put an end to the compulsory support of Congregational churches by the taxpayers in certain New England States, especially Connecticut. Toleration is now universal in civilized countries, so far as permission to worship is concerned, but some restriction still exists as to bell-ringing by Roman Catholics in Sweden, and there is a certain degree of intolerance toward Protestants in some South American republics. Nowhere, however, in any country pretending to civilization is persecution on account of religious belief permitted by law.

In all ages enlightened minds have favored toleration. It was the rule among the ancient Greeks, and also among the Romans, until religion became so identified with state affairs that refusal to accept the state religion was treason to the government. Toleration was unknown in practice during the Middle Ages, although it had earnest advocates among Christians, Mohammedans and pagans. In modern times toleration has been a growth of the past three centuries. As late as the early part of the last century men were imprisoned in New England for refusing to pay taxes for maintenance of the local church. England removed Roman Catholic disabilities in 1829, but did not admit Jews to Parliament until 1858. In a legal sense toleration is now coextensive with civilization and semi-civilization, but education only can make it effective by causing a fraternal and tolerant spirit to take the place of intolerance and fanaticism, wherever the latter prevail.

TOLERATION ACT, a statute of William and Mary, under which freedom of worship was granted to Protestant dissenters from the Church of England, provided they made a declaration against transsubstantiation and took the oaths of allegiance and supremacy. See Toleration.

TÓLIMA, tō-lē'mä, Colombia, a volcano rising from the central cordillera of the Colombian Andes to a height of 18,320 feet.

TOLL, Eduard, Baron **von**, Russian explorer: b. 1850; d. 1902. In 1885 he began to explore the Post-Tertiary fauna of the Jana region, and in 1893 found the body of a mammoth in the ice near the delta of the Jana. Later he commanded the *Sarja* expedition which wintered on the west coast of Kotelnoi Island (1901–02) and discovered large deposits of Post-Tertiary fauna, including mammoths, reindeer, etc., in the great ice-cliffs there. With F. G. Seeberg he started south in November 1902, and perished on Bennett Island, where their records were found by Kolchek a year later. Consult Toll, Emma, 'Die Russiche Polarfahrt der Sarja' (Berlin 1909).

TOLL, a tax paid or a duty imposed for a privilege granted, such as the payment claimed by owners of a port of entry for the privilege of landing or shipping goods; the fee exacted by those who erect or maintain a bridge for the privilege of passing over the same; a portion of grain retained by the miller as his compensation for milling; a charge made by the owners of a fair or exhibition for the privilege of exhibiting or selling goods; a compensation for services, especially for transportation, as canal or railway toll. In the United States tolls, as applied to bridges and highways, are a subject for State legislation, while those applying to rivers and harbors are usually in the province of Congressional action. Tolls were at one time of international importance, since they were exacted on certain straits and tidal rivers by virtue of the sovereignty of a particular state, such as the Scheldt tolls and sound dues levied by Denmark. The tendency in the United States is to abolish tolls, and most bridges and highways are now free to the public. See TAXATION.

TOLMAN, Herbert Cushing, American Greek scholar: b. South Scituate, Mass., 4 Nov. 1865. He was graduated at Yale and studied at the universities of Berlin and Munich. He received his Ph.D., from Yale and was honored with the degree of D.D., from Peabody College and S.T.D., Hobart College, and LL.D., University of Nashville. From 1894 he was head of the Greek department of Vanderbilt University and is the author of several works on classical and philological subjects. His ‹Ancient Persian Lexicon and Texts› and ‹Ancient Persian Language and Cuneiform Supplement› were adopted immediately after publication by the universities of Germany and were recognized by foreign philological reviews as superseding what had yet been done in that line of research, while the American *Journal of Philology* and the New York *Nation* spoke of the author as the leading American authority in the field of ancient Persian language. He was the first to identify positively the hitherto unknown season of the Persian month, Garmapada, with June-July, an identification of great value to historians in fixing accurately several important dates. Dr. Tolman was elected president of Hobart College in 1913, but declined. In 1915 he was appointed dean of the College of Arts and Science of Vanderbilt University.

TOLMAN, William Howe, American safety engineer: b. Pawtucket, R. I., 2 June 1861. In 1882 he was graduated at Brown University and from 1894 to 1898 was general agent of the New York Association for Improving the Condition of the Poor. He also served as secretary of the New York commission on public baths and of the improved housing council of the same city. He is founder and from 1908 to 1916 was director of the American Museum of Safety. He has taken part in several international housing congresses and is member of several societies for social betterment, both American and foreign. Dr. Tolman is the author of ‹History of Higher Education in Rhode Island› (1891); ‹Municipal Reform Movements in the United States› (1894); ‹Handbook of Sociological Reference for New York City› (1894); ‹Report on Public Baths and Comfort Stations› (1897); ‹The Better New York› (1906); ‹Social Engineering› (1909); ‹Hygiene for the Worker› (1912); ‹Safety› (1913); also ‹Industrial Betterment,› a monograph prepared for the United States Section of Social Economy, Paris Exposition of 1900, and various review articles.

TOLOWA, tôl'ō-wä, originally the name of a village, but extended to designate a tribe of the Athapascan stock of North American Indians occupying the coast of California from a point a few miles north of the mouth of Klamath River northward to a short distance beyond the boundary of Oregon and the valley of Smith River. They were noted basketmakers and subsisted largely on salmon and other fish. In 1862 they were placed on a reservation, which was abandoned six years later, since which time they dwindled and largely disappeared.

TOLSTOY, COUNT **Lyof Nikolaievitch,** Russian novelist and social reformer: b. Yasnaya Polyana, government of Tula, 9 Sept. 1828; d. Astapova, 20 Nov. 1910. He studied languages and law at the University of Kazan. In 1851 he went to the Caucasus district as an ensign of artillery and he served in the defense of Sevastopol during the Crimean War. To this period of his career belong his earliest literary works, among them the autobiographical ‹Childhood, Boyhood and Youth,› the brilliant descriptions of the Crimean campaign entitled ‹Sevastopol in December 1854,› ‹Sevastopol in May 1855› and ‹Sevastopol in August 1855› and ‹The Invasion.› He left the army on the conclusion of the war and went to Saint Petersburg, where he made the acquaintance of Turgenev (q.v.) and other distinguished Russians and soon after he published ‹The Snowstorm› and ‹Two Hussars.› His first foreign journey was made in 1857 and marks an epoch in his spiritual history and on his return he retired to his estate to live a simpler life. He was greatly interested in the condition of the peasantry and founded a free village school on his property, for which he prepared reading and other textbooks himself. At the end of two years, however, the school was closed, both on account of opposition of the government inspectors and also the lack of interest among the masters and pupils. Later when he asked permission to reopen his school the government flatly refused. His ‹Family Happiness› was issued in 1859 and was soon followed by ‹Three Deaths› (1859), ‹Polikuschka› (1860) and others. In 1862 he married the daughter of a Moscow physician. The next period of his life saw the production of the two works upon which his literary reputation chiefly rests, ‹War and Peace› (1865–68), dealing with Napoleon's invasion of Russia, and ‹Anna Karenina› (1877), a powerfully realistic study of human passion and its effects. Soon after the completion of the latter novel Tolstoy began to develop his characteristic views of religion and its application to individual and social life. He believes that the Sermon on the Mount literally interpreted is the supreme law of the Christian life and he lays special stress on the precept, «Resist not evil.» His system has much in common with the anarchist-communism of his fellow-countryman, Kropotkin, but its peculiar religious basis gives it a unique character. In 1901 he was formally excommunicated by the Holy Synod of the Russian Orthodox Church and in a reply to the edict of excommunication he clearly enunciated his religious and theological views. These include the denial of the Trinity, of the deity of Jesus and his vicarious atonement, of orthodox conceptions of the future world, of every kind of sacramentalism and similar dogmas and are substantially identical with those of modern spiritual Unitarianism. Among the works of his latest period, in which his religious and social views are more or less expounded, are the following: ‹What the People Live By› (England 1889); ‹What to Do› (England 1889); ‹My Confession›; ‹My Religion›; ‹The Death of Joan Ilyitch› (1886); ‹Where Love is there God is Also›; ‹The Kingdom of God is Within You›; ‹The Kreutzer Sonata› (1890); ‹Work while ye have the Light› (England 1890), a tale of the early Christians; ‹The Power of Darkness,› a drama; ‹The Fruits of Enlightenment' (1891), a satirical comedy; 'Master and Servant'; 'Politics and Religion'; 'Patriotism and Christianity' (1894), on the Franco-Russian alliance, and 'What is Art?' (1898). 'Resurrection' (1900) is a powerful novel of the same type as 'Anna Karenina.' There are American translations by Dole, Hapgood and others (22 vols., New York 1902), and by Leo Wiener (24 vols., Boston 1904–05). Tolstoy gave up all privileges of rank in order to live a life of labor and asceticism and during the great Russian famine he found abundant opportunity for carrying out his gospel of social service. (See ANNA KARÉNINA; WAR AND PEACE). Consult De Vogüé, 'Le Roman Russe' (1888); Dupuy, C. E., 'Great Masters of Russian Literature' (New York 1886); Garnett, Constance, 'Tolstoy: His Life and Writings' (London 1914); Howells, W. D., 'My Literary Passions' (New York 1895); Lloyd, J. A. T., 'Two Russian Reformers: Ivan Turgenev and Leo Tolstoy' (ib. 1911); Löwenfeld, 'Leo Tolstoi' (1892); Maude, A., 'The Life of Tolstoy' (2 vols., New York 1910; 4th ed., 1911); Merezhkovsky, D. S., 'Tolstoy as Man and Artist' (ib. 1902); Rolland, R., 'Tolstoy' (ib. 1911); Tolstoy, I. L., 'Reminiscences of Tolstoy' (ib. 1914); Turner, 'Count Tolstoy as Novelist and Thinker' (1888).

TOLTECS, tŏl'tĕks or tōl-tāks', an Indian tribe said to have occupied portions of the Mexican plateau previous to the advent of the Aztecs. Little is known of the race and that little only through Aztec traditions and picture writing. They are supposed to have come from the north and to have been supreme in their territory from the 7th to the 11th century. Their principal city was Tolan, where they settled about 661 A.D. from which they got the name Toltec. Lists of their kings or chiefs are extant — but these are considered untrustworthy by antiquaries. The hero-god Quetzalcohuatl is supposed to have lived in their cities before their overthrow, which came in 1013, when they were driven south by savage tribes. Aztec records tell no more of the Toltecs, but from the fact that the Quichés and other tribes from the north are known to have settled in Guatemala about this time, the inference is strong that they were banished Toltecs.

TOLUCA, tō-look'kä, Mexico, capital of the state of Mexico, 36 miles southwest of Mexico City, on a division of the National Railway, 8,761 feet above sea-level. Three steam railways — the Mexican National, the Toluca and San Juan and the Toluca and Tenango, all narrow gauge, supply transportation facilities and there is a well-equipped street railway. The city is situated in the beautiful valley of Toluca, just over the mountain range which forms the western background of the national capital. This valley, which lies at the foot of the Toluca Mountain, is one of the most notably productive and beautiful spots of the republic. The city was founded by the Matlatzinca Indians and was advanced to the title and rank of city in 1677. The industries include a brewery, large flour-mill, glass-bottle factory, two packing-houses and several modern creameries. There is a local bank — the Bank of the State of Mexico — a branch of the National Bank and an agency of the Bank of London and Mexico. The city is well paved and provided with beautiful plazas, one of which contains a monument in honor of the patriot priest, Hidalgo, dedicated in 1900. In another plaza is a life-size figure in bronze, of Morelos, while in still another is an imposing monument to Columbus. A museum supported by the state occupies a spacious building and the State Library, containing some 11,000 volumes, is located in the immediate vicinity. The principal buildings are the palace of the state government, the municipal palace, the Scientific and Literary Institute, civil hospital, School of Trades and Arts. Pop. 33,000.

TOLUENE, methyl benzene, $C_6H_5CH_3$, is an aromatic hydrocarbon present in American petroleum, in wood-tar and in coal-tar. Upon distillation coal-tar yields a fraction known as light oil, boiling at 100°–120° C. The toluene of commerce has been obtained from this fraction. Toluene has also been prepared (1) by the dry distillation of tolu balsam; (2) by heating brombenzene with methyl iodide and metallic sodium (Fittig Synthesis); (3) by treating benzene with methyl halide and dry aluminum chloride (Friedel-Craft Synthesis); (4) by heating toluic acid with lime.

The enormous demand for toluene created by the European War, made it the subject of a number of patents. According to Fr. P. 479, 295, the compound is made by passing hydrochloric acid into boiling methyl alcohol in the presence of dehydrated zinc chloride and conducting the methyl chloride produced into a mixture of benzene and dry aluminum chloride. Other patentees claim to have obtained toluene from gas-tar naphtha by distilling under pressure at 130°–240° C. (U. S. 1,225,237); or, from gas-drip naphtha, by passing it with steam and water-gas through checkerwork heated to about 800° C. (U. S. 1,230,087). To these may be added the widely-advertised «cracking» process, according to which toluene and benzene have been obtained by heating oils, containing aliphatic or aromatic hydrocarbons, at prescribed temperatures and pressures. The process has been tried on a large scale, but its success as a commercial enterprise has been seriously questioned. Of much greater importance are the improvements inaugurated for the extraction of the maximum amount of toluene from coke-oven or city gas supplies. It has been known for some time that only a small fraction of the toluene obtained from the by-products coke-ovens is recovered for commercial purposes, the greater proportion finding its way into city gas during the process of distillation. Toluene recovery plants have, therefore, been installed in all parts of the United States with the object of stripping illuminating gas of this material. As a result of this measure the toluene output for 1918 has probably exceeded 20,000,000 gallons. The maximum output for 1912–13 was not over 500,000 gallons.

Toluene is a colorless liquid with a boiling point of 110° C. and a specific gravity of 0.872 at 15° C. It is an excellent solvent for many organic compounds. With a side-chain that readily responds to a number of reagents and with a nucleus that can be nitrated, sulphonated, halogenated or reduced, toluene is capable of forming a large number of derivatives which are either useful commercial products or intermediates for the manufacture of explosives, synthetic dyes, perfumes, drugs, substitutes for sugar and poisons used in chemical warfare. Trinitrotoluene, saccharin, indigo-blue, brombenzyl cyanide, benzyl chloride, benzotrichloride, benzoic acid, nitrobenzaldehyde, toluidine, are some of the more important derivatives of this hydrocarbon.

V. S. BABASINIAN,
Lehigh University.

TOLUIDINE, $C_6H_4\langle^{CH_3}_{NH_2}$ exists like all disubstitution products of benzene in the ortho, meta and para modifications. When toluene is treated with nitric acid, a mixture of ortho- and para-nitrotoluenes is obtained. The reduction of this mixture yields the corresponding ortho- and para-toluidines. These are separated by strongly cooling the product, when the ortho compound remains as an oil, while the para compound solidifies and may be removed by filtration. Or, the mixed toluidines are treated with a quantity of sulphuric acid insufficient to effect complete neutralization; the ortho compound is now removed by distillation, while the para compound remains behind as a sulphate. It has also been noted that the oxalate of para-toluidine and its phosphate are much less soluble than the corresponding derivatives of the ortho compound. Upon these properties are based a number of methods for the separation of the two modifications. On account of the high cost of manufacture, meta-toluidine is used to a limited extent only. It has been obtained by the reduction of meta-nitrobenzal chloride. Meta-toluidine may be readily obtained from meta-nitrotoluene, but the latter can only be prepared on a commercial scale by indirect methods.

Ortho-toluidine is an oily liquid. It boils at 197°–199° C. and has a specific gravity of 1.102 at 4° C. Meta-toluidine is also an oily liquid with a boiling point of 203° C. and a specific gravity of 1.0041 at 4° C. Para-toluidine is a solid which crystallizes in leaflets. It melts at 43°–45° C. and boils at 190° C.

Ortho- and para-toluidines are important intermediates in the dye industry. After diazotization they may be coupled with *G* Acid to form Ponceau *G*, with *R* Acid to produce Ponceau *RT*, with beta-naphthol sulphonic acid *S* to form Orange *GT*, and with dioxy-naphthalene sulphonic acid *S* to yield Azofuchsine *B*. Magenta is an oxidation product of a mixture of toluidines and aniline; Primuline is a fusion and sulphonation product of pera-toluidine and sulphur; Mauveine, Safranine, Chloramine Yellow, Cochenille Scarlet 2*R*, Spirit Yellow *R*, etc., are obtained from toluidines. Simple derivatives of toluidines have also been used for the manufacture of certain pigments; thus diazotized nitro-toluidines have been coupled with beta-naphthol producing Orange *R*, Fast Red *HL*, Lithol and Fast Scarlet *R*.

V. S. BABASINIAN,
Lehigh University.

TOM, known as **BLIND TOM.** See BLIND TOM.

TOM, Asia, a river in southern Siberia, in the government of Tomsk, rising in the Abakanic Mountains and after a course of 450 miles flowing northward into the Obi. It begins to be navigable at Kusnezk.

TOM BROWN'S SCHOOL DAYS, a story depicting English public-school life, written by Thomas Hughes and published in 1857, when the author was a young barrister of three-and-thirty. It leaped at once into a deserved popularity it has never lost. Tom is a typical middle-class lad, with the distinctive British virtues of pluck, honesty and the love of fair play.

TOM JONES. 'The History of Tom Jones, a Foundling,' a novel by Henry Fielding, was published 28 Feb. 1749 — a red-letter day in the calendar of English fiction, for this work in the opinion of many stands at the head of all novels ever written in our language. It succeeded several most interesting experiments in the novel of contemporary manners such as Richardson's 'Pamela' and 'Clarissa Harlowe,' Smollett's 'Roderick Random,' and his own 'Joseph Andrews.' When Fielding wrote 'Tom Jones,' his intellect, wonderfully observant and penetrative, was in full maturity; his pen had been long practised in the drama and the essay and in fiction; his mind was highly cultivated in the ancient and modern literatures; he had associated with all classes of people, the high and the low, and he had thereby gained a knowledge of the men and women of his time unsurpassed by any one then living. His aim was to present the very form and pressure of the age, and on the effort he expended "some thousands of hours." Having in mind the ancient epics, he divided his novel into 16 books, each with an initial chapter on the art and morality of that "new province of writing" which he claimed to be introducing to the British public. In its original form, 'Tom Jones' filled six volumes, containing, all told, about 350,000 words.

For his comprehensive view, Fielding began his delineation of character in the country with two Somerset gentlemen — Mr. Allworthy and Squire Western, the one a Hanoverian and the other a Jacobite. Into the household of Allworthy he placed a sister, Bridget, her maid, Deborah, a pair of nephews, Tom Jones and Master Blifil and their tutors, Square the Deist and Thwackum, the orthodox divine. Into the household of Western he placed a sister, Diana, a daughter, Sophia and her maid and former nurse, Mrs. Honour. Then, after describing life in the country while Tom and Sophia were growing up, he brought most of his characters up to London for contrast and interaction with more highly-seasoned men and women of the town. The manner in which Fielding conducted his story, concealing until the end the mystery of Tom's birth, has received the highest praise ever since the novel first appeared down to the eulogy by the late W. E. Henley. Scott, for example, likened the narrative to the easy flow of a river through lands affording wide prospects; Coleridge thought the nice structure of the plot was equaled only by that in the very greatest dramas, such as the 'Œdipus' of Sophocles. And in general, little exception has ever been taken to Fielding's craftsmanship beyond his introduction of the tale of the 'Man of the Hill,' the matter of which a modern novelist would manage differently. It is not to be inferred that Fielding laid out a plot by compass and rule. At the outset, he probably had in mind his conclusion, but nothing more. He wrote at leisure, remembering what he had seen and heard, letting his story develop as he proceeded, casting his mind backward and forward and gathering up at the end all the threads of his narrative into a consistent and impressive whole. This is the way that literary genius, in distinction from mere literary talent, works, and achieves its ends.

Apparently Fielding drew his characters in the main from real life. Where he followed his model too closely or where he deviated too far from it, his success was only partial. Squire Allworthy, who had an original in Ralph Allen, the philanthropist of Bath, is altogether too good for this world; he lacks those elements which really make a man, lovable and humorous as he is. Likewise Blifil, for whom no original was ever claimed, is hardly more than a stage villian, whose hypocrisy is so transparent that it should have been detected long before it had a chance to work its mischief. Thwackum and Square, though rather artificial creations, are always entertaining, for they have enough of reality to support their humorous pretensions. Partridge, the schoolmaster and barber, superstitious and afraid of his dreams, interested Voltaire greatly. Minor characters, like Diana Western, Mrs. Honour and Bridget Allworthy, are almost always admirable. For a superb creation we turn to Squire Western — the fox-hunting squire who goes to bed drunk and gets up in the morning before daybreak to follow the hounds, who loves his daughter better than all other creatures except his kennel, who quarrels with his sister, swearing great oaths referential. Under the excitement of Sophia's refusal to marry Blifil, he develops into a veritable whirlwind of contending passions. The height of the storm is reached in certain scenes with his sister, which, brutal as they are, have never been surpassed for humor in this language of ours. His daughter, Sophia, for whom Fielding's own wife, Charlotte Cradock sat, is a portrait of unusual charm. She is a real woman depicted in all her beauty, fine breeding, self-poise, modesty, vivacity and independence when the inevitable struggle comes between paternal tyranny and the promptings of her own heart. She wins the first great battle in our fiction for the enfranchisement of her sex.

The crux of the novel has always been the hero, who resembles Fielding himself in temperament but not in the incidents of his career. He is kind, generous, chivalrous and perfectly honest, but he is lacking in practical sense, and so falls into all sorts of mistakes in conduct. He loves Sophia desperately and would win her at all hazards. This passion, however, does not protect him against the allurement of other women, and herein lies the trouble. Generous critics overlook the boy's affairs with Molly Seagrim and Mrs. Waters, but they halt at the intrigue with Lady Bellaston. Had Fielding thrown in a word of explanation over that intrigue, Coleridge would have excused all. Here arises a question that may be interminably debated. Fielding himself thought no explanation necessary. He depicted the young man of his time as he was without comment. In thus keeping his art true to nature he acted rightly.

The influence of 'Tom Jones' cannot be well considered apart from the influence of Fielding's other works. The novel was immediately translated into French, Dutch and German, and subsequently into Spanish, Italian, Polish and Russian. The French imitated it, dramatized parts of it and turned it into a comic opera. The Germans appropriated its disquisitions on the art of fiction and to some extent wrote novels in its style. 'Tom Jones' has probably been reprinted in English a hundred and fifty times. To pass by a host of imitations, it suggested the general outline of plot to Scott for 'Waverley,' his first novel; its spirit permeates the best work of Thackeray, and 'Pendennis' was written in direct imitation. In short, to 'Tom Jones' nearly all succeeding novelists are indebted who have aimed to depict life, not as it ought to be, but as it really is. Since Fielding's day fiction has extended its scope to include things never dreamed of by him; but for method, manner and procedure his art is the source. Scott called him "the Father of the English Novel."

WILBUR L. CROSS.

TOM MOUNTAIN, in Hampshire County, Mass., between Holyoke and Northampton, and overlooking the Connecticut Valley. Though only 1,214 feet in height, thousands of tourists ascend Mount Tom each year on account of the grand view from its summit.

TOM THUMB. See STRATTON, CHARLES SHERWOOD.

TOM-TOM, or **TAM-TAM,** a native East Indian drum used by musicians, jugglers, public criers, etc. It is generally cylindrical in form, the depth of body being about three times the diameter of the heads, of which there are two. It is made of resonant wood or of hard-baked earthenware, and the heads are covered with skins, drawn tight by side-lacings, as in the modern drum. It is beaten with the fingers or the open hand and produces a hollow monotonous sound. Similar instruments used by the natives of western Africa receive the name of tom-tom, as do also certain types of Chinese gongs.

TOMAH, Wis., city in Monroe County, on the Chicago, Milwaukee and Saint Paul Railroad, 42 miles northeast of La Crosse. It is the site of a government industrial Indian school and contains the railroad bridge works and a large saw-mill. Pop. about 4,000.

TOMAHAWK, Wis., city in Lincoln County, on the Chicago, Milwaukee and Saint Paul and the Marinette, Tomahawk and Western railroads. It is 23 miles north of Merrill on the Wisconsin River. The principal industries are saw-mills, woodworking plants, pulp and paper factories and a tannery. Pop. about 3,000.

TOMAHAWK, a weapon of warfare of North American Indians, a light war axe. Before the advent of the white traders the head of the axe was usually a piece of stone sharpened at both ends and put through a piece of wood for a handle; sometimes the stone was two-edged and more like a modern double-axe; sometimes hard horn was sharpened and used in the place of the stone. But the white traders brought the natives, iron hatchet heads and the stone ones were gradually discarded. These hatchets had but one cutting edge, the other shorter end being formed into a hammer-head, or oftener into the bowl of a pipe, which communicated with a tubular hollow made in the handle, thus made to serve as a pipe stem. From the custom of the Indians of burying their tomahawks when they made peace with a foe comes the custom of saying that two opponents who have made peace have "buried the hatchet."

TOMALES, tō-mä'lĕs, a bay on the coast of California, reaching the ocean, about 40 miles north of San Francisco. It is a narrow inlet of the Pacific, the railroad is near and parallel to its eastern shore, and Tomales Point is on the west, separating the bay from the ocean. The village of Tomales is a short distance inland.

TOMAN, or **TOMAUN**, a current gold coin of Persia, varying in value from $1.75 to $2.25 or even higher. In Persia it is reckoned as the equivalent of 100 schahis or shakis.

TOMATO, a perennial herb (*Lycopersicon lycopersicon*) of the family *Solanaceæ*. It is a native of western South America, whence it was introduced into cultivation in Europe during the 16th century. At first the wrinkled fruits were regarded with suspicion or disfavor, and were more popular as garden ornaments than for other purposes. During the 18th century both yellow and red-fruited sorts were known, but not until the middle of the 19th century was there a decided improvement in the form of the fruit. At the beginning of that century the fruits were used to a small extent for pickles and preserves, but less for other purposes. The development of the tomato both in its form and its popularity as a vegetable is mainly due to the care of plant-breeders, who have eliminated the wrinkles from the fruit, and to the development of perfect methods of canning. The annual consumption of tomatoes, both as a salad and cooked or preserved in various ways, aggregates thousands of tons in the United States, where the crop is more widely grown than in any other country of the world. The season opens in mid-winter in Florida and the Mississippi delta, and advances northward until September, when it ends in Canada. Considerable quantities of tomatoes are forced in greenhouses at various seasons, but especially during the spring months.

Though perennial in its native country and in other frostless climates, the tomato is best known in the temperate regions as an annual herb. It is a straggling, clammy, ill-smelling, grayish-green plant with variously formed pinnate leaves and small racemes of small yellowish flowers, followed by fleshy many-seeded berries which in some improved horticultural varieties weigh more than a pound. Several botanical varieties have been recognized, among which the following are best known: Cherry tomato (*L. lycopersicon*, var. *cerasiforme*), grown in gardens for its little yellow or red globular fruits which are used for home-made preserves and pickles; pear and plum tomato (var. *pyriforme*), similar to preceding except in form of fruit; large-leaf tomato (var. *grandifolium*), a group of varieties originated during the closing quarter of the 19th century, and including some of the most important commercial varieties; the common tomato (var. *vulgare*), the most widely cultivated form in America. One other species is cultivated, more for ornament than for its fruit, which, although edible, is too small for general household use; it is the current tomato (*L. pimpinellifolium*), also known as the German raisin tomato. The plant is very spreading and branchy, with small egg-shaped leaves and long racemes often bearing more than 30 currant-like red fruits. It has produced hybrids with the preceding species, and is useful for covering unsightly objects during the summer. The former species has been grafted upon its close relative, the potato, but the two plants have never been known to cross-fertilize. These grafts are interesting as curiosities but not otherwise.

Several other plants have been called tomato; the best known are probably the husk tomato (*Physalis pubescens*), also known as the strawberry tomato, ground cherry and dwarf cape gooseberry. It is popular in gardens for its fruits which are made into preserves or kept in their husks in cool dry rooms until needed for use in mid-winter. The name strawberry tomato is also given to *Physalis alkekengi*, better known by its specific name and as the winter cherry or bladder cherry. The red fruits are edible, but are not generally relished. The plant is chiefly ornamental on account of its very showy blood-red calyces. The tree tomato (*Cyphomandra betacea*) is cultivated to a small extent for its light brown, egg-shaped fruits, which resemble the tomato in flavor but are rather more musky and acid.

In cool climates the seeds are generally sown under glass in early spring and pricked out in flats, boxes or pots when the first pair of true leaves appear, allowing them to stand in the former not closer than three by three inches, or two by six inches. Abundant ventilation should be given at all times and the temperature kept rather low to make the plants grow stocky and able to adapt themselves readily and without check to the conditions of the field. At this time they should be about five inches tall. The sturdier the plant, the less is it likely to suffer under ordinary conditions and care when set in the field, the earlier will it commence to bear, and the more profitable will be the fruit.

Whenever possible the tomato should be planted on rather rich loamy soil of medium texture and well exposed to the sun. Good drainage is essential. It is generally considered best to apply stable manure to previous crops, because the applications made during the current year are thought to impair the flavor of the fruits as well as to induce a rampant growth of vine at the expense of productivity. In the field the plants are usually set four to five feet apart each way, and when grown extensively each sixth or eighth plant in the row is omitted and each 15th or 20th row is skipped, so as to facilitate harvesting with least injury to the vines, wagons being driven across the field to distribute the empty crates and collect the full ones. Until the vines spread and thus prevent tillage, cultivation is given weekly to keep the surface lose and free from weeds. Often a top dressing of some readily soluble fertilizer is given after the plants have been in the field about a month.

For home use and for fancy markets tomatoes are often trained in many ways, especially to stakes, upon slat frames and trellises. For such the plants are subjected to more or less pruning and tying, which usually vary with individual growers. But the single stem is usually conceded to be the best method of growing such plants. The advantages secured by training are early ripening and better colored, larger sized and superior flavored fruits.

Since the vines are tender to frost the tomato is usually cut short before mid-autumn. There are, however, at that time many fruits approximately mature, besides large quantities less advanced. The former may be gathered and ripened in warm rooms or sunny windows, and by storing in cool places from which they can be removed to warmth as needed the season may be extended several weeks after the vines have been destroyed. The greener fruits are widely used for making sweet pickles, chowder and «India relish.»

In greenhouses the tomato is one of the most popular vegetable crops. Though it is often grown in special houses or as the leading crop it is probably more frequently employed as a successor to carnations and some other greenhouse plants, which either commence to fail in the early spring months or have a smaller sale when brought into competition with spring flowers. The fruits are sought about Easter time and from then until the out-door plants commence to bear the greenhouses may often be very profitably employed. Hand pollination is generally considered essential to the setting of the fruit and the labor this involves is often a drawback on account of its expense. The plants are raised usually from seeds, sometimes from cuttings, or the rooted tips of plants which previously occupied the benches. They are planted in soil similar to that in favorable fields, either in solid beds, on shallow benches, or in boxes or pots, the second being preferred. The plants are usually trained to a single stem supported either by a stout cord suspended from the sashbars, or upon a trellis, the former preferred. Two feet apart is the favorite distance; five feet the preferred height; a minimum temperature of 60° is the lowest night temperature; 65° being preferred by most growers. Abundant light and air must be given at all times, but water must be carefully controlled, especially in cloudy weather, because the plants are apt to grow too rapidly to foliage if water is in excessive supply. During the winter months an average crop of three pounds of fruit to each plant trained to a single stem is considered fairly good. In the spring months four pounds is perhaps below the average. Unless 30 cents a pound can be realized during the winter the crop is rarely paying, and many growers set the profitable figure at 40 cents a pound. In the spring a somewhat lower price with a rather higher average production makes the crop profitable.

The more progressive tomato growers are alive to the fact that the so-called plant diseases which have been reported injurious to the tomato are more readily prevented by intelligent management of the plants than by the use of so-called remedies. Every effort is, therefore, made to keep the conditions in the seed bed as well as in the field as favorable as possible. Adequate ventilation, rather low temperature and limited water supply are found conducive to the health of the seedlings. And sturdiness at the time of setting in the field is a safeguard against subsequent troubles. Growers whose methods produce inferior plants, or who are negligent in various other respects, often suffer serious losses; and perhaps the majority still have recourse to fungicides, none of which have been found fully satisfactory and in some instances have failed completely from the first trial.

Many insects feed upon the tomato, but very few are usually numerous enough to do serious damage. The best known are probably the boll-worm (*Heliothis armigera*), the tobacco-worm (*Phlegethontius carolinus*) and various species of cutworms. Flea-beetles, potato-beetles and thrips are also well-known enemies. As a rule, however, they are not responsible for serious damage. The larger species are generally picked off by hand and the smaller are driven away to other plants by the use of repellants such as tobacco dust, Bordeaux mixture, etc. See FUNGICIDES; INSECTICIDE.

Consult Bailey, 'Standard Cyclopedia of Horticulture' (New York 1916); and numerous bulletins of the agricultural experiment stations and of the United States Department of Agriculture.

M. G. KAINS,
Horticultural Consultant.

TOMB, a vault, cavity, niche, excavation or chamber to receive the dead body of a human being; also the monument erected to his memory, or the combined structure that answers both of these purposes. Among Eastern peoples it early became the practice to place the remains of the dead in excavated chambers or in case the dead bodies were first burnt, to place urns containing the ashes in such chambers. These structures even in times of great antiquity were decorated within or without with appropriate inscriptions. Early tombs often bore character writing, telling of the parentage and the place of residence, perhaps the station of life, of the deceased, and, in the case of heroes, the history of achievement was in all likelihood carved on the walls of the structure. Rude peoples whose only means of written expression was by picture-writing have employed that language to tell of the exploits of dead. Tombs are often designed to contain the remains of more than one person, and of such were the Roman columbarium and the Egyptian pyramids. With some races tombs were made elaborate objects of art; with others, such as the Greeks, they were highly artistic but simple and tasteful. The stele or flat stone set up to mark a grave was often highly carved, and the stele of Dexileos in Athens is famous. Large edifices built as monuments to the dead are not found in Greece, but were common in the semi-Greek lands of Asia, the most noted being that of King Mausolus of Caria, whence comes the term mausoleum (q.v.). Roman monuments were of great splendor, as is attested by the few examples remaining to the present time. They were often of large proportions, the so-called «Castle of Saint Angelo» being nothing else than the tomb of the Emperor Hadrian and his successors, «stripped of its sculptures, its marble colonnade, its probable conical superstructure,» and crowded with defensive works that make of it a veritable citadel. Other tombs of great splendor are found outside of the walls of Rome and although despoiled and in some instances subverted to the purposes of other, adjacent architectures, they testify to the wealth and the artistic attention which the Romans bestowed on them. Pompeii, too, had its long street of magnificent tombs, which has been partially uncovered outside the limits of the city proper. In portions of Italy and in some of the older Spanish-American towns burials in the cemeteries were made in niches which rose row above row, terrace-like. In the niches rested coffins bearing the bodies. Burial in churches was prohibited during the earlier centuries of Christianity, but from the custom of erecting churches or chapels over graves of martyrs the custom arose to bury monarchs under the cover of the church, and the most important tombs of the Middle Ages are generally so situated. The earlier examples consist of a simple stone coffin or sarcophagus, often with a low, gabled lid and a sculptured cross. Following these come the altar-tombs, in the form of a table, and subsequently, in the 13th century, a species of tomb consisting of a sarcophagus bearing a recumbent figure of the deceased, the whole surmounted by a canopy, often of exquisite beauty of design. Still more stable are the churchyard tombs of which fine examples are seen in the tombs of La Scala in the churchyard of Santa Maria Antica in Verona. The tombs of the Renaissance period became more and more complex. The sarcophagus was disguised and subordinated to the decorations of sculptured upholstery and groups of symbolical or mythological figures. Immediately following the Middle Ages the beauty and value of the statuary employed partly compensated for the loss of architectural design, as is the case in Michelangelo's tombs; but in succeeding years this redeeming feature was lost and tomb architecture rapidly declined. The tomb placed in a niche in a church naturally suggested the memorial tablets of more recent years. The tomb of the Virgin Mary is venerated near Jerusalem, in the Cedron Valley. The sepulcher is completely below the present ground level, and is reached by a stone stairway descending 48 steps. Consult the pamphlet by Jean Baptiste Christyn, ‹Les tombeaux des hommes illustrés,› etc. (1674); and the paper by L. S. Mercier, ‹Le tombe di Verona› in ‹Teatro italiano moderno› (Vol. II, 1792).

TOMBAC, an alloy consisting of from about 75 to 85 parts copper, mixed with 15 to 25 parts zinc, and used as an imitation of gold for cheap jewelry. When arsenic is added it forms white tombac.

TOMBIGBEE, tŏm-bĭg'bĭ, a river rising in Tishomingo County, in the northeast corner of Mississippi, and flowing south to Lowndes County where it enters Pickens County in Alabama. It continues an irregular southern course and unites with the Alabama River, 45 miles north of Mobile Bay. From the point of junction the waters enter Mobile Bay by Mobile (q.v.) and Tensas (q.v.) rivers. The total length is over 500 miles. It is navigable for 412 miles from Mobile Bay, to Aberdeen, Miss.

TOMBS, The, a noted city prison in New York. It occupies the entire block bounded by Center, Elm, Leonard and Franklin streets, and is connected with the criminal courts building on the other side of Franklin street by an upper story closed passage, locally known as the «bridge of sighs.» The Old Tombs building built in 1838 was replaced in 1898 by a new structure on the Center street side. Part of the old building still standing indicates something of the fine Egyptian architecture in which the original structure was built. Its proportions are grand in their beauty, but they are dwarfed into insignificance by its situation and by the high commercial buildings surrounding it. The prison covers the site of the pre-Revolutionary gibbet and, therefore, stands on ground long dedicated to penal punishment. Its internal arrangement is into corridors of cells which rise in tiers one above the other. It is used almost wholly for prisoners awaiting trial.

TOMCOD, or FROST-FISH, a species of small cod (*Microgadus tomcod*) of the North Atlantic, usually abundant in the mouths of the rivers after the first frosts of autumn. It is from 4 to 12 inches long, olive green above, and silvery below. It is a valued food-fish, and has several useful relatives on the Pacific Coast.

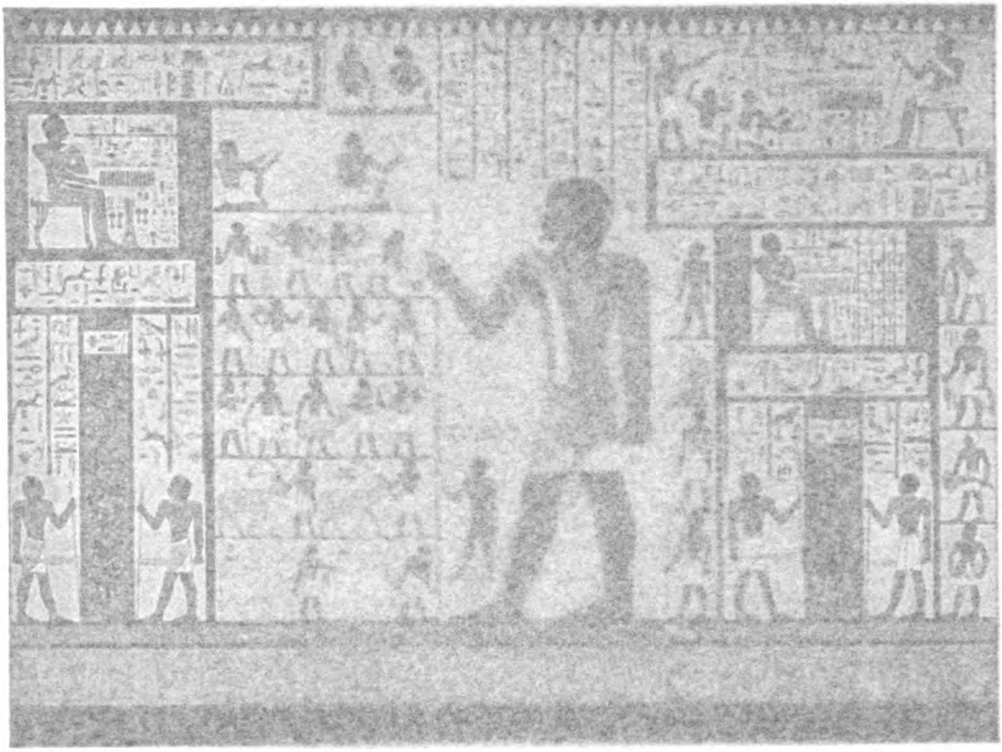
TOME, Jacob, American philanthropist: b. York County, Pa., 13 Aug. 1810; d. Port Deposit, Md., 16 March 1898. In 1833 he settled in Port Deposit, and there acquired a fortune in business. In 1864 he entered political life as State senator, being chairman of the Senate Finance Committee, and was instrumental in reducing the indebtedness of the State greatly to the public welfare. His public benefactions include a large gift to Dickinson College, and the establishment of a technical school, the Jacob Tome Institute, at Port Deposit, which he erected at a cost of $1,600,000, and by his will permanently endowed with an equal sum.

TOMÉ, tō'ma. See CONCEPCIÓN, CHILE.

TOME, a post-village in Valencia County, New Mexico, on the Rio Grande River. Early in the 16th century it was settled by the Spaniards and for years was the seat of government. In 1708 it was destroyed by the Comanche Indians, since which time it never has regained its importance in the locality. Pop. about 500.

TOME INSTITUTE. See JACOB TOME INSTITUTE.

TOMLINSON, Everett Titsworth, American author: b. Shiloh, N. J., 23 May 1859. He studied at Williams College, and afterward taught in various preparatory schools in the Eastern and Middle States, but in 1894 began to devote himself to literature, particularly to the writing of historical books for children. His publications include: ‹The Boy Soldiers of 1812› (1895); ‹Three Young Continentals› (1896); ‹Tecumseh's Young Braves› (1897); ‹Washington's Young Aide› (1898); ‹A Jersey Boy in the Revolution› (1899); ‹Under Colonial Colors› (1902); ‹Young Folks' History



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INTERIOR OF TOMB OF

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TOMÉ, to'mā. See Concepcion, [illegible]

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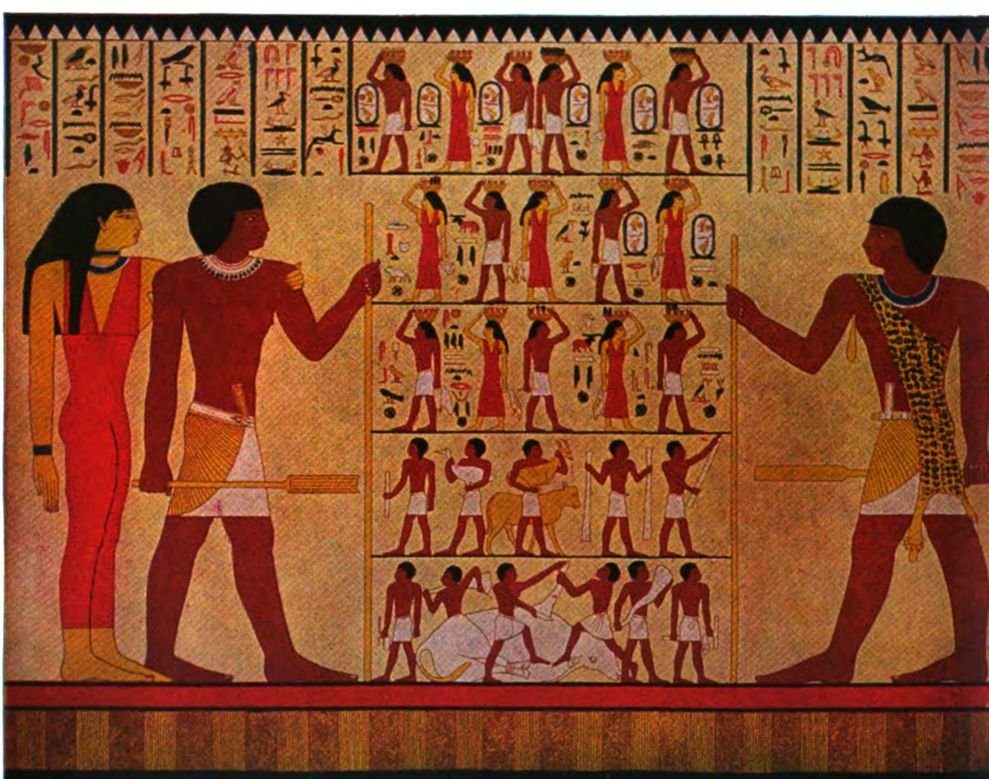
INTERIOR OF TOMB OF PRINCE MERAB. (Part 1)



INTERIOR OF TOMB OF PRINCE MERAB. (Part 2)

of the Revolution' (1902); 'Young Americans in the British Isles'; 'A Lieutenant Under Washington' (1903); 'The Rider of the Black Horse' (1904); 'The Red Chief' (1905); 'Soldiers of the Wilderness' (1905); 'Winning His Degree' (1905); 'Four Boys in the Yellowstone' (1906); 'Marching Against the Iroquois' (1906); 'The Camp Fire of Mad Anthony' (1907); 'The Fruit of the Desert' (1907); 'Four Boys in the Land of Cotton' (1907); 'Mad Anthony's Young Scout' (1908); 'Four Boys on the Mississippi' (1908); 'Light Horse Harry's Legion' (1910); 'The Champion of the Regiment' (1911); 'The Young Minute-Man of 1812' (1912); 'The Young Sharpshooter' (1913); 'Scouting With Daniel Boone' (1914); 'Places Young Americans Want to Know' (1915).

TOMMASEO, tŏm'mä-zä'ō, **Niccolo**, Italian philologist and philosopher: b. Sebinico, Dalmatia, about 1802; d. Florence, Italy, 1874. He studied law in Padua but turned to literature and became known as a poet and critic. He was forced to leave Florence where he was colloborating with Viessieux in publishing his 'Antologia' which was suppressed by the government. He then went to Paris where he devoted his time to making the French and Italians better acquainted. In 1838 he went to Corsica where he made a collection of popular songs which were published in 1841. He returned to Venice where he was arrested in 1848 for his liberal opinions, but was freed by the Manin insurrection. Finally settling down in Turin he began (1854) to publish his great dictionary of the Italian language. He was distinguished for his vast and accurate knowledge as a philologist and for his constant efforts to educate the people. He was the author of a number of works in Italian.

TOMMY ATKINS, a generic nickname applied to the British soldier. It originated many years ago from certain printed forms — enlistment applications and military accounts, wherein, as a model, the name «Thomas Atkins» was inserted, like the mythical «John Doe» of American documents.

TOMOCHICHI, tō'mō-chē'chē, a chief of the Yamacraw branch of the Creek confederacy: b. in the town of Apalachicola, Ga., about 1642; d. at Savannah, Ga., 1739. He withdrew from the confederacy and with his followers went to live at Yamacraw Bluff on the Savannah River where he was instrumental in making a treaty of peace with Governor Oglethorpe and in securing the ceding of important territory by the Creeks. In 1734 he accompanied the governor on a visit to England.

TOMPKINS, Charles H., American soldier: b. Fort Monroe, Va., 12 Sept. 1830; d. Washington, D. C., 1895. He studied at West Point, but resigned without completing his course. In 1856, however, he enlisted in the dragoons, and was promoted first lieutenant in the Second United States Cavalry in 1861. At the outbreak of the Civil War he was assigned to service in the defense of the national capital and was engaged in one of the first reconnoitering expeditions. He was particularly distinguished for bravery in the Shenandoah campaign, and was brevetted brigadier-general in 1865. After the war he served as chief quartermaster in various divisions of the army, and in September 1894 was retired with the rank of colonel.

TOMPKINS, Daniel D., American statesman: b. Westchester County, N. Y., 21 June 1774; d. Staten Island, 11 June 1825. He was graduated at Columbia College in 1795, and afterward admitted to the bar, but soon entered political life. He was a member of the New York legislature and of the State Constitutional Convention in 1801 and in 1804 was elected to Congress, but was appointed to the State Supreme bench, and accepted that position instead of going to Washington. He was governor of New York in 1807–17 and in 1817–25 was Vice-President of the United States. He took an active part in the War of 1812, and was one of the strongest and most able opponents of slavery. It was largely through his influence that the bill abolishing slavery in New York was kept before the legislature, but he did not live to see its enactment.

TOMPSON, Benjamin, American poet: b. Braintree, Mass., 14 July 1642; d. Roxbury, Mass., 13 April 1714. He was graduated from Harvard and was long a teacher at Cambridge. He wrote 'New England's Crisis,' a long poem of King Philip's War.

TOM'S RIVER, N. J., village, county-seat of Ocean County, on the Pennsylvania and the Central of New Jersey railroads, about 50 miles east of Philadelphia, 36 miles southeast of Trenton and four miles from Barnegat Bay. It is one of the colonial villages of New Jersey, and in the Revolutionary days was a haven for privateers. The salt found here made it a place of importance in the settlement days. On 24 March 1782 the village was burned by the British. It is now a favorite summer resort. The chief industries are connected with the care of summer guests; but there are considerable shipments of cranberries, farm products, fish and oysters. It contains five churches, four schools and one bank. Permanent population about 1,500.

TOMSK, Asia, in western Siberia, (1) capital of the government of its own name, on the Tom (q.v.). It is the seat of a governor and of a bishop and of the educational district of West Siberia. It has 20 Russian churches, monastery, convent, synagogue, mosque, university with three faculties and 900 students, technological institute, theological seminary and various other schools for both sexes; also various scientific societies, Russian musical society, theatre, library, halting station for deported Russians, banks, harbor, etc. The industrial works comprise tanneries, distilleries, wagon factories, etc. There is a brisk transit trade with Siberia. It lies on a branch of the Siberian Railroad. Tomsk dates from 1604. Pop. about 117,000. (2) The government has an area of about 330,000 square miles and is in the south and southeast mountainous, and embraces the Altai system. The Obi and its tributaries are the chief streams. There are vast swamps in the flat districts. The climate is very cold and unhealthful. Storms and earthquakes occur often. Pop. about 4,000,000.

TON, a measure of weight and capacity, equivalent to 20 hundred-weight. As the historical «hundred-weight» of Great Britain and the United States contains 112 pounds, the ton is reckoned as 2,240 pounds. This is known as a «long» ton. In some of the States legislation has made the ton consist of 2,000 pounds, being 20 hundred-weight of 100 pounds each. This is known as a «short» ton. United States laws make the ton equal to 2,240 pounds when not otherwise specified. A metric ton is 1,000 kilograms, or 2,204.6 pounds avoirdupois. A ton of earth is the equivalent of 21 cubic feet. As a measure of capacity, of a vessel or a car, a ton is 40 cubic feet; this is an «actual» ton. The «register» ton contains 100 cubic feet. See TONNAGE.

Applied to liquid measure the word, in the form tun, was in common use with the old English wine dealers. A tun of beer contained 216 gallons, of 282 cubic inches each, while a ton of wine contained 252 gallons of 231 cubic inches each.

TONALITY, *in music,* the character and quality of tone. Good tonality demands: correctness of pitch, the production of sounds slightly out of tune being termed of doubtful tonality; correctness of intonation; and correctness of key relation, a passage wanting in definiteness of key or scale being termed of uncertain tonality. The word has been adopted by art critics and is applied to painting in considering the system of tones, or the color-scheme, of a picture.

TONAWANDA, tŏn-a-wŏn'da, N. Y., city in Erie County, on the Niagara River, Tonawanda Creek and Erie Canal, and on the New York, Central and Hudson River Railroad, opposite North Tonawanda and 10 miles north of Buffalo. Several railroads pass through and electric lines connect with Buffalo and Niagara Falls. It is in a fertile agricultural region, and on account of the good water power extensive manufacturing interests have been developed. The chief manufactures are steel, lumber and lumber products and paper boards. There are about 75 manufacturing establishments making products of the annual value of $2,500,000. The educational institutions are a high school, public and parish schools and a public library. The two banks have a combined capital of over $300,000. Pop. 9,147.

TONBRIDGE, English market town in Kent, 29 miles southeast of London, on the Medway River. It contains the remains of a mediæval castle which stands near the entrance to the town, a parish church and a grammar school founded about 1550. It is noted for the manufacture of a peculiar kind of wooden ware known as «Tonbridge ware.» Pop. about 17,500.

TONDO, tōn-dō', Philippines, a district of the city of Manila, the most northern district on the bay shore. The streets are mostly narrow, the houses built of cane and nipa; it contains a large church and convent, the station of the Manila and Dagupan Railroad, and the city slaughter-house. The inhabitants are mostly fishermen and laborers engaged in the tobacco and cigar industries.

TONE, Theobald Wolfe, leader of the United Irishmen: b. Dublin, 20 June 1763; d. there, 19 Nov. 1798. He was graduated at Trinity College, Dublin, in 1786, practised law for a time without much success and gradually politics became his absorbing interest. He held republican opinions, and believed that Ireland ought to assert her rights as an independent nation; but the objects of the clubs of United Irishmen started at Belfast and Dublin in 1791 were limited to legislative reform. In 1792 he was appointed secretary of the general Catholic committee. The government came to know through a spy that he had given information in 1794 on the question of invasion to an emissary of the French government, but they permitted him to leave the country and go to America. He sailed from New York to France in 1795, and urged the French government to undertake an invasion of Ireland. He was adjutant-general in Hoche's abortive expedition against Ireland in 1796, and he afterward served under Hoche on land. He accompanied one of the small French expeditions sent to assist the Irish rebels in 1798, but was taken prisoner after a brief naval engagement near Lough Swilly. He was tried by court-martial at Dublin, convicted of treason, and ordered to be executed within 48 hours. He, however, cut his throat in prison. Consult the edition of his journals and political works, with a 'Life,' by his son (1826), of which a new edition, entitled 'The Autobiography of Wolfe Tone,' was issued by Barry O'Brien (1893).

TONE, sound considered with reference to its pitch, timbre, duration and volume. Nearly all tones in music are composite, consisting of several simple constituents having different rates of vibration and known as partial tones. They vibrate according to fixed laws, the pitch depending on the nature of the sonorous body and the mode of producing its vibration. The partial tone having the lowest pitch (and usually the loudest sound) is called the prime or fundamental tone, while the other partial tones are called accessories, harmonics or overtones. Tones differ in quality or timbre according to the number and relative force of their partial tones. A pure tone is a simple harmonic vibration. The seventh tone of a scale is called the characteristic tone; two tones coalescing are termed combinational. The interval of a major second is called a tone or whole tone, half of such interval being a semitone. When a piano key is sounded it produces a note, and the character of that note is a tone; the character of all the notes of an instrument gives the tone of the instrument. See NOTE; PITCH.

TONER, Joseph Meredith, American physician: b. Pittsburgh, Pa., 30 April 1825; d. Washington, D. C., 1 Aug. 1896. He was graduated at the Jefferson Medical College in 1853 and established himself as a medical practitioner in Washington in 1855. He was the originator of the plan for the American Medical Association Library established in Washington in 1868 and made a part of the Smithsonian Institution, founded the Providence Hospital and Saint Ann's Infant Asylum in Washington and in 1871 the Toner lectures under the auspices of the Smithsonian Institution. He devised the system of symbols for the indication of geographical localities which was adopted by the Post Office Department and made valuable researches into early American medical literature. His collection of 26,000 medical books and 18,000 pamphlets he presented to Congress in 1882. His publications include

'Maternal Instinct, or Love' (1864); 'Medical Register of the United States' (1874); 'Annals of Medical Progress and Medical Education in the United States' (1874); 'Medical Men of the Revolution' (1876), etc.

TONGA, tŏng'gạ, or **FRIENDLY ISLANDS,** Polynesia, a group of islands under British protection, situated in the south Pacific Ocean, mainly between lat. 18° 30' and 22° 30' S., and between long. 173° and 176° W., southeast of the Fiji Islands and southwest of Samoa. They are sometimes classified as three groups, the Tonga-tabu, Haabai and Vavan. The group consists of about 200 islets with a total area of 390 square miles. The largest, Tongatabu, is 20 miles long. The islands are partly volcanic and mountainous, partly of low coral formation. They have been subject to considerable changes in modern times by volcanic action. The soil is fertile and the vegetation luxuriant. The chief exports are copra, fruits, mats and sponges. The annual imports and exports total each about $350,000, trade being mainly with Australia and New Zealand. The larger islands are visited every fortnight by vessels of the New Zealand Union Steamship Company. The inhabitants belong to the finest of the Polynesian types. They are peaceful, civilized and Christian, being mostly Wesleyan Methodists. Excellent schools and a college have been established by missionaries. The immediate ruler is King George II and native council, whose capital is Nukualofa on Tongatabu. The islands were discovered by Tasman in 1643. In 1845 they were united under one king. In May 1900 they were declared under British protection. Pop. about 24,000, including 380 Europeans.

TONGAS, tŏng'gạz, a tribe of the Kaluschan stock of North American Indians, residing around Cape Fox and at the mouth of Portland Canal, southeastern Alaska. They number about 250.

TONGRES, tôngr, Belgium, a town in the province of Limburg, on the Geer, 12 miles north of Liege. The church of Notre Dame (1240) is the first dedicated to the Virgin in the north. The cloister belongs to the 10th century. The industrial works include tanneries, distilleries and hat manufactories. The population before the war was about 10,000.

TONGUE, the principal organ of the sense of taste and an essential part of the apparatus of speech in human beings. The name tongue is also given to various structures in invertebrates, as the proboscis of a lepidopter or the odontophore of a shellfish. In man the tongue is attached by its base or root to the hyoid bone and to the epiglottis. Its tip, sides, upper surface and part of its under surface are free. Its under surface is fixed to the lower jaw by the genio-hyoglossi muscles and from its sides the mucous membrane is reflected on the inner surface of the gums. In front of the under surface a fold of the mucous membrane is specially developed and is named the frenum linguæ. The upper surface is convex and bears a deep middle line, the raphé, which ends behind in a deep follicle or sac — the foramen cœcum. Two-thirds of the forward portion of the organ are rough and bear the characteristic structures known as papillæ, in which the sense of taste resides. The posterior third is smooth and exhibits the openings of numerous mucous glands. The substance of the tongue consists of numerous intrinsic muscles, which are named superior and inferior longitudinal and transverse muscles. The mucous membrane consists of an upper layer or cutis supporting papillæ and covered with epithelium. This cutis supports the blood-vessels and nerves and into it the muscles of the tongue are inserted. The papillæ, which cause the characteristic roughness of the tongue, are of three kinds. The circumvallate papillæ number from eight to 10. They are of large size and are placed on the hinder part of the upper surface and extend from the raphé in two diverging lines. Each of these papillæ consists of a rounded central and flattened disc, situated in a cup-shaped depression or fossa. The exposed part of the papilla is itself covered with numerous smaller papillæ. The fungiform papillæ are more numerous than the circumvallate and are scattered irregularly over the upper surface of the tongue, but are most plentiful on its apex and sides. They are of large size, of rounded, projecting form and of a deep red color. The filiform or front papillæ are of very small size and are arranged in rows corresponding with the rows of the circumvallate papillæ. In structure the papillæ are like those of the skin (q.v.) and contain loops of capillary vessels as well as nervous filaments. The mode of termination of the nerves in the papillæ is hardly determined. Numerous follicles and mucous or lingual glands exist on the tongue, the functions of these latter being the secretion of mucus (q.v.). The epithelium (q.v.) of the tongue is of the flat or scaly kind, resembling that of the epidermis or outer skin, but the deeper cells of the epithelial layer do not contain any pigmentary or coloring matter. The muscular halves or substance of the tongue are divided in the median line by a fibrous septum. The arteries are derived chiefly from the lingual and facial trunks and the nervous supply is distributed in the form of three main nerves to each half of the organ. The gustatory branch of the fifth nerve supplies the papillæ in front and those of the sides. The lingual branch of the glossopharyngeal nerve supplies the mucous membrane at the sides and base and also the circumvallate papillæ, while the hypoglossal nerve is distributed to the muscular substance of the organ.

The gustatory nerves and glossopharyngeal branches are the nerves which provide the tongue with common sensation and also with the sense of taste, the hypoglossal nerve being that which invests the muscles of the tongue with the necessary stimulus. The conditions which appear to be essential for the exercise of this sense are: (1) the solution of the matters to be tasted — that is, their presence in a form in which their particles may readily come in contact with the nerves of taste, there being thus a strong analogy between the sense of taste and that of touch, since the latter sense must be in a manner exercised before the taste of any substance can be perceived; (2) the presence of a specialized gustatory nerve, a necessary condition for the exercise of this sense. Occasionally it happens, however, that other stimuli than those produced by the actual contact of sapid substances with the nerves of taste may excite that sense. If a current of cool air be directed on the tongue a saline taste is perceived; and a smart tap on the tongue will produce a taste analogous to that excited by electricity. A minute current of electricity can be detected by the tongue which is not observable by the contact of the hand. It appears necessary that the surface of the tongue itself should be moist, in order that the gustatory sense may be exercised, and hence the inability to taste substances when the palate and fauces are dry and parched. The tongue itself does not appear to be the exclusive seat of this sense. The soft palate, uvula, tonsils and upper part of the pharynx in all probability exercise this sense, although in a minor degree when compared with the tongue. The middle of the tongue appears to be most feebly endowed with the sense of taste, the most sensitive region of the organ being the tip and edges. The tongue may occasionally lose its sense of taste and retain its sensibility to touch, or vice-versa. Surprising variations in taste occur. While some substances taste alike when touched by every part of the tongue, other substances taste differently when applied to different parts of the tongue. Sensations of taste, or at any rate of the impressions of taste, may remain for long periods after the substances tasted have disappeared, while the frequent repetition of the same taste dulls the sense. This sense may also be excited by internal stimuli as well as by those of external kind.

In the articulation of words, the modulation of sounds, the tongue plays an important part among the organs of speech; and in mastication, swallowing and nearly all the actions performed by the mouth the tongue is more or less concerned.

Various mechanical devices and structures thought to resemble the human tongue in some respect are so named, as the pole of a wagon, the fastening pin of a buckle, a vibrating slip in a musical reed, the tang of a tool, a strip of leather for closing the front gap in a laced shoe, etc.

TONGUE-FISH, an English name, corrupted from the French *langue*, applied to young soles and other small edible flatfish found along the shores of the English Channel. The term has been applied by Jordan to the American genus *Symphurus* of sole-like fishes occurring on both United States coasts.

TONGUE-TIE, an abnormal attachment or adhesion of some part of the tongue to some portion of the surrounding structures of the mouth. The ordinary form of tongue-tie consists in an abnormal development of the frenum. The tongue, in consequence, cannot be extended beyond the lips, and suction and mastication, as well as speech, are impeded.

TONGUES, Confusion of, the punishment inflicted on the builders of Babel, according to the Biblical narrative, when God so confounded their language that they could not understand each other, though up to that time there had been among them only one language. The result was that the building of the tower was abandoned, and those who had been engaged in its erection were dispersed over various lands (Gen. xi, 1-9).

TONGUES, Gift of, a gift bestowed in connection with the Pentecostal descent of the Holy Spirit. According to the Acts of the Apostles, when the members of the Church had assembled with one accord on the Jewish day of Pentecost, suddenly a mighty, rushing wind entering, pervaded the building in which they had assembled, cloven tongues as of fire descended on each and those on whom they were bestowed began to speak with "other tongues, as the Spirit gave them utterance"— the Parthians, Medes, Elamites and others, who repaired to the place when news of the miracle reached them, bearing testimony to its reality (Acts ii, 1-21).

TONIC SOL-FA. See SOL-FA, TONIC SOL-FA, or MOVABLE DOH SYSTEM.

TONICS, remedies which are alleged to promote nutrition and thus increase the strength or tone of the body when it is reduced. They are assumed to restore the functional activity of various tissues, and not merely increase the vigor of muscular fibres, as was formerly believed. Tonics are of two kinds, medicinal and non-medicinal. The medicinal tonics are variously classified, according to the part of the body they principally act upon, or to the effects they produce. Those that increase the secretions of the alimentary canal, the saliva, gastric or intestinal juice, etc., and so aid digestion, are spoken of as gastric or stomachic, intestinal and digestive tonics. Examples of such tonics are the vegetable bitters, cinchona and its derivatives, quassia, columbo, gentian, taraxacum, nux vomica and the salts of strychnine; dilute mineral acids, small doses of alcoholics and extracts of malt. Valuable adjuncts to the above are vegetable and animal pepsin. Blood or hæmatic tonics are those designed to improve the quality of the blood, and include iron and its salts, arsenic, manganese, mercuric chloride and quinine. Vascular tonics, often administered to increase the tone of the bloodvessels, include belladonna, digitalis, ergot and strychnine. General tonics act chiefly as nutrients, being assumed to gradually increase the weight of the body or exert a stimulating or modifying action upon the tissues. Cod-liver oil and other fats, salts of phosphorus and arsenic act as general tonics. Nerve-tonics, or nervines, which are given to increase the tone of the nervous system, include arsenic, strychnine, salts of iron, zinc, copper and silver, phosphorus, ammonia chloride and quinine; cardiac tonics, digitalis, strophanthus, strychnine stimulate the heart's action. The non-medicinal tonics (usually classed as general tonics) are sunlight, friction, electricity and massage; also exercise in the open air, and cold in its various forms and applications, as air, the shower and sponge bath and sea-bathing. Within recent years there is more and more doubt of the benefit of so-called medicinal tonics and an increased resort to nature's sunlight, air and exercise, the stimulation of the cold bath, etc.

Tonics are employed in conditions of debility of the body generally, or of its different parts, but unless properly used they do harm. For example, bitter tonics should not be used when there is severe pain and tenderness of the epigastrium, a heavily coated tongue and vomiting of blood or much mucus. While iron is an efficient remedy in most forms of anæmia, it is not always easily assimilated and it is generally futile in chronic wasting diseases and in organic affections.

TONIKA, tŏn'ę-ką (also **TONICA** and **TUNICA**), a tribe of North American Indians, forming a distinct linguistic stock, and formerly residing on the Lower Yazoo in Mississippi. They were first described by De Soto as the Tanico. They were allies of the French colonists in their contests with neighboring tribes, and in 1699 were reported to occupy 260 cabins extending over four leagues. In 1706 they were driven away by the Chickasaws and Alabamas, and in 1730 were defeated by the Natchez, who burned their village and killed a number of them. The remainder retired to the lower Mississippi, where, in 1760, they occupied three villages, and in 1802 numbered about 400 souls. The Tonikas were an agricultural tribe; they flattened their heads and wore very little clothing; the women made pottery and a fabric from the mulberry. Polygamy was not common. There are now a very few survivors of the tribe, near Marksville, La., who speak their native language as well as Creole and English.

TONK, India, a small native state of the Rajputana, east of Ajmer-Merwara. Area, 2,553 square miles; pop. about 303,000. It yields Britain an annual revenue of about $650,000. The capital, Tonk, about 60 miles south of Jaipur has a population of 55,000.

TONKA, tŏn'kä, Lower Siam. See PUKET.

TONKA, TONCA, TONGA, or **TONQUIN BEAN**, is the fragrant seed of the leguminous tree *Dipteryx odorata*, native to the northern countries of South America. The tree grows to 80 feet in height and bears fruits which are pod-like, oblong and fibrous and contain a single seed. This is of the shape of an almond, but larger, in a shining black coat. Tonka beans have the fragrance of new-mown hay, due to the same odorous principle, prismatic coumarin, as the sweet vernal grass and melilot. They are used for their aroma, either whole or powdered, for scenting clothes, snuff and in perfumery and even as a substitute for vanilla.

TONKAWA, tŏng'ką-wä, a nomadic tribe of North American Indians, comprising a distinct linguistic stock. They formerly roamed over the plains of Texas, were noted for their cannibalistic practices and were regarded as outlaws by the surrounding tribes. Early in the 19th century they were reported to number between 2,000 and 3,000, but in 1857, when they were settled on a reservation on the upper Brazos River, in Texas, their number was officially estimated at fewer than 1,000. During the Civil War (5 Jan. 1862), owing to their refusal to join the Comanches, Delawares and others in an insurrection against the whites, the latter Indians attacked a party of some 200 Tonkawas, comprising more than half the tribe, killing all of them. The remainder returned to Texas where they stayed until 1884, when they were placed on a reservation in Oklahoma. Here the few survivors now live with the Poncas.

TONKIN, tŏn-kēn', **TONKING**, or **TONGKING**, French Indo-China, a territory under French protection, bounded on the north by China, on the east by the Gulf of Tonkin, on the south by Anam and on the west by Laos. Area, 46,400 square miles. It is divided into 14 provinces and includes about 8,000 villages. It consists of two mountainous regions surrounding on three sides the large alluvial plain and delta region of the Song-koi (Red River), also an intermediate region of plateaux. The Song-koi flows through the centre of the territory from northwest to southeast and opens a navigable waterway extending in the rainy season as far as Lao-kay. The Song-bo (Black River) rises in Yunnan and joins the Song-koi, the largest river in the Mekong, forming a large portion of the western boundary. The principal mineral resources are deposits of coal, iron, copper and gold. The climate is hot and humid and the alluvial plain of Tonkin produces some of the best rice in the world. Sugar, cotton, tea, Indian corn and opium are also cultivated to a great extent, and on the higher ground there are coffee plantations. The manufacturers include silk, paper, cotton textiles, indigo and oils. Commerce has rapidly increased, the exports, chiefly rice, maize, sugar cane, silk, cotton, coffee, tobacco and animal products amounting to about $10,000,000 annually. The imports in 1915 totaled $8,000,000, being largely tools, machinery and beverages. The principal port is Hai-fong, which has steamship connection with Hongkong, Yokohama and Cochin-China. Railroads run from Hanoi to Hai-fong and Nam-dinh to Lungchow and to Yunnanfu and to the Chinese frontier. There are ocean cables connecting with Hongkong and Hue. Hanoi is the capital, and, since 1902, also the capital of the whole of French and Indo-China. Tonkin was an independent state until 1802, when it became a province of Anam. The latter is still its nominal position, although the Anamite vice-royalty was superseded in 1897 by a French residency, and the French protectorate is more direct here than in Anam proper. The provinces are governed by a resident and vice-resident, and each is subdivided into four military territories under commandants. Pop. estimated in 1911 as 6,119,720, with 33,000 Chinese and 6,132 Europeans.

TONKIN, Gulf of, Indo-China, an arm of the China Sea extending northward between French Indo-China and the Chinese island of Hainan. It is about 400 miles long and 200 miles wide. It forms the coast of the protectorate of Tonkin and receives the commerce brought down by the important river Song-koi from a rich agricultural region.

TONKS, Oliver Samuel, American teacher of art: b. Malden, Mass., 24 Dec. 1874. He was graduated at Harvard University, where he took his Ph.D. degree in 1903, and was a Fellow of the American Classical School at Athens (1901–02). He served as assistant curator of the department of classical art in the Boston Museum of Fine Arts (1903), was instructor in Greek at the University of Vermont (1904), lecturer at Columbia (1905) and preceptor in art and archæology at Princeton (1905–11). He then became professor of art in Vassar College. He collaborated in writing 'The Art Museum and the Public School' (1912).

TONNAGE, the carrying capacity of a ship. As this capacity is variously measured the word has several special meanings. As it comes from the shipyard the ship's capacity is rated as "dead weight tonnage." As it is measured by maritime surveyors and registered as of so many tons, its capacity is spoken of as "gross registered tonnage" and "net registered tonnage," both figures being given, as in different ports dues are collected variously, sometimes on the gross and sometimes on the net tonnage. War vessels, which have no "carrying capacity" in the mercantile sense, are rated by their "displacement tonnage." Still another form is recognized among shippers as "cargo tonnage" or "measurement tonnage."

Deadweight Tonnage is the amount of deadweight tons of 2,000 pounds which can be loaded upon a vessel at load-line (q.v.) draught when she has on board her full complement of stores and fuel.

Displacement Tonnage is the weight of sea water actually displaced by the vessel. It is computed usually by calculating from the drawings of the ship by the naval architect the cubic content of the immersed hull in feet and adding to that figure the number of cubic feet in the propeller, the shafting exterior of the hull and the submerged portion of the rudder. This total is divided by 35, as 35 cubic feet of sea water weigh almost exactly one ton.

In ascertaining the carrying capacity of a ship under the old style of measurement (abbreviated O. M.) the depth of the vessel was assumed to be the same as its breadth and the tonnage was obtained by multiplying the length by the breadth by the depth and dividing the product by 94, the quotient being the tons burden. But this rule was found to be impracticable, since shipbuilders sought to evade tonnage and harbor dues by building their ships very narrow and deep. In 1835 the British Parliament remedied these defects by new measurement laws, which were amended by the Merchant Shipping Acts of 1854 and 1894. Under this system, known as the Moorsom, actual measurements of the depth of the vessel are made at certain intervals, the number of which depends on the length of the tonnage deck, and at these points transverse areas are computed.

Gross and Net Registered Tonnage.— For purposes of measuring tonnage the United States practice divides vessels into six classes based upon their length (the British into five). These lengths and the number of longitudinal sections into which they are respectively divided are as follows: I, vessels under 50 feet long, into six parts; II, between 50 feet and 100 feet, into eight parts; III, between 100 and 150 feet, into 10 parts; IV, between 150 and 200 feet, into 12 parts; V, between 200 and 250 feet, into 14 parts; VI, over 250 feet, into 16 parts. These divisions are set out on the "tonnage deck," which in a vessel with less than three decks is the upper deck; in a vessel with three or more decks is the second deck, counting from below. The length of this deck is measured on its centre line from the inside of its innermost plate or plank at the bow to the innermost side of the plate at the stern, but making allowance for rake. The stations being marked off at equal distances upon this line, measurement of the transverse areas are made at each station, the depth being first taken. This is the distance from one-third up the round of the beam at the bottom to the top of the deck timbers, allowing two and one-half inches for ceiling. If this depth at midship is more than 16 feet the figure representing the depth is divided into six equal parts and a transverse measurement is made at each division, and at the top and the bottom. Counting from above, the second, fourth and sixth measurements are multiplied by four, and the third and fifth are multiplied by two. These products are added together, and to the sum thus obtained are added the top measurement and the bottom measurement. This total is then multiplied by one-third of the equal vertical distance into which the depth was divided, and the total is accepted as the transverse area at that station. These transverse areas are numbered consecutively from the bow to the stern. Omitting the first and the last, the second, fourth and each succeeding area with an even number is multiplied by four; and the third, fifth and each succeeding area with the odd number is multiplied by two. These several products are then added together and the first and last also added, and the sum is then multiplied by one-third the equal longitudinal distance between the stations. The total is the cubic content of the ship in cubic feet. This figure is arbitrarily divided by 100 and the quotient is the underdeck tonnage. To this is added the number of cubic feet in all deckhouses and permanently covered-in spaces which are above the tonnage deck, and which are or may be used to pack with cargo or use as transport for passengers. These additions are also divided by 100 and added to the underdeck tonnage to make the *gross registered tonnage.* The *net registered tonnage* is computed by deducting from the gross the cubic content of the engine-room (including the shaft tunnel), the crew space, cable lockers, coal bunkers, chartrooms and all space needed in the navigation of the ship, and such part of the space in the double bottom as is not available for fuel, stores or cargo. In calculating the ship's registry tonnage it is a common practice to compare the engine space with the gross tonnage, and if it is above 13 per cent, and under 20 per cent, to make an arbitrary deduction of 32 per cent for a screw vessel and 37 per cent for a sidewheeler in making the figure for the net tonnage. These deductions from the gross tonnage differ at different ports, and for this reason the ship always carries its gross tonnage figures as well as the net figures for the calculation of port and canal dues by the local authorities.

Cargo or Measurement Tonnage is the true cubic content of the ship in cubic feet divided by 40 — on the principle that a ton (2,000 pounds) of average cargo will occupy 40 cubic feet in the ship's hold. It is on this assumption that the freight charges for transportation are fixed. Where the cargo will weigh more than 2,000 pounds to the 40 cubic feet of space, as with stone, metals, cement, etc., the actual weight of the material is used as the basis of figuring the freight.

The British system of measurement was adopted by the United States in 1864, and subsequently, with slight variations, by all maritime nations. At Suez, Panama and other canals where tolls are based on tonnage, the management have established rules of their own for measurement, as they have to deal with vessels of all nations. Under modern rules account is taken of the space in double bottoms, now commonly utilized for feed, water, oil, fuel, etc., and no allowance of more than 5 per cent of the gross tonnage for crew space is countenanced. Deckhouses, however, which are used only as lounging rooms by passengers accommodated elsewhere in the vessel are also deducted in arriving at net tonnage.

TONOMETER, *in music,* an instrument for measuring the pitch of tones, such as a tuning fork or a set of graduated tuning forks. The best-known tonometer was invented by Scheibler in 1834, and was subsequently improved by König. It consisted of an exceptionally perfect set of tuning forks with an apparatus for determining the exact number of vibrations per second produced by a given tone. An instrument for measuring tension in a liquid, or of the eyeball, is also termed a tonometer.

TONQUIN. See TONKIN.

TONSILS and TONSILITIS. See NOSE AND THROAT, DISEASE OF.

TONSON, Jacob, English publisher: b. London, 1656; d. there, 2 April 1736. In 1678 he opened his shop at the Judge's Head, Chancery lane, near Fleet street. He soon became the publisher of Dryden's works, and continued as such for many years. In 1690 he completed the purchase of the publishing rights of 'Paradise Lost,' and afterward claimed that he made more on that poem than on any other. About 1700 he removed his shop to a place in Gray's Inn Gate. When the Kit-Cat Club (q.v.) was founded he was made its secretary. He purchased a house at Barn Elms and provided a room there for the meetings of the club. In 1710 he moved to the Shakespeare's Head. Here he continued until his retirement from business in 1720. His name is associated with nearly all the literary men of his time: with Pope, whose pastorals appeared in Tonson's 'Miscellany' (1709); with Addison, for whom he published 'Cato' (1713) and for a time issued *The Spectator;* with Congreve, Steele, Waller, etc. Wycherley spoke of him as having long acted as gentleman-usher to the Muses. He published Rowe's edition of Shakespeare (1709).

TONSURE, the shaving of a space on the top of the heads of Roman Catholic and Greek priests, performed as a solemn rite since the 6th century. The custom of cutting away the hair in token of the dedication of a person to the service of God is very ancient, being mentioned as early as the 4th century. The tonsure furnishes a means to distinguish the higher clergy from the lower, as the extent of the tonsure increases with the rank. The shape of the bare space also varied at different peroids. Many religious orders (for example, the Franciscans) allow only a narrow strip of hair around the head to grow; all above and below is shaved. Shaving the hair precedes consecration; it is performed by the bishop. It was never ordered by the Holy See or any "provincial or national council," says W. H. W. Fanning, and by tacit consent the custom has been discontinued in English-speaking countries.

TONTINE, tŏn-tēn', a form of annuity or financial assurance in which gain accrues from survivorship. The word is derived from the name of Lorenzo Tonti, a Neapolitan who settled in Paris in the time of Cardinal Mazarin and who invented this style of life annuity. Tonti proposed the system to the French government as a method of raising money and while the plan was not adopted, still it served as a model on which all future tontines were operated. The members of Tonti's association were to subscribe the sum of money needed by the government and were to receive life shares in the society. There were to be 10 classes of subscribers, according to their age, and for each class a fixed sum was to be divided yearly among the members of the class. When a member died his share was divided with the rest among the members of the class so that the death of each member benefited all those remaining, and the profit to the last few survivors in each class was enormous, while the sole survivor received the entire sum of interest accruing to his class. Upon his death the interest ceased and the borrower obtained the capital. In 1689–92 the system was used by Louis XIV, who was sorely in need of funds. He organized a tontine with a capital of $70,000,000, which lasted for a period of 40 years. The sole survivor drew an annual income of $367,500 from his original investment of $1,500. During the following century the tontine was frequently used in France and in Great Britain, and in at least one instance in the United States, in order to raise large sums of money. A disastrous private tontine in France, known as the "Caisse Lafarge," was established in 1791. When 60,000,000 francs had been subscribed into the company it was found that either through gross error or fraud the interest promised was an impossible one and the subscribers owing to the financial panic then prevailing lost not only their interest but their capital as well. The last public tontine in England was opened in 1789 and the interest, amounting to $210,150, was paid as late as 70 years after that date. The Irish tontines, established 1773–77, drew as many as 3,500 members. Tontines in the United States were at one time popular as a means for raising money for the erection of large buildings. The New York Tontine Society, founded in 1790, was wound up 1870–78, while tontine buildings were erected in New York, New Haven, Albany and other American cities.

Although tontines in their old form were long ago abandoned by financiers, the tontine system as applied to life assurance has given rise to an important modification of the usual insurance policies. What is known as the tontine dividend policy has the following distinctive features: The holders of such policies constitute a class by themselves; they do not participate in profits until after the lapse of the tontine period, usually 10, 15 or 20 years; the representatives of the insured in case of his death before the commencement of the dividend period receive only the sum mentioned as the face value of the policy; no surrender value is allowed to anyone who relinquishes his policy before the dividend period and all profits from whatever source are reserved until that period, when the accumulated dividends are to be equitably divided among the holders of such policies as are then in force. This form of policy is now in very little favor. Modifications from these general principles have been practised by various societies. For further information consult F. De Peyster's 'History of the Tontine Building' (1855). See INSURANCE.

TONTO (Spanish, «foolish»), an inappropriate name applied by the Spanish colonists of Arizona in the 19th century to a number of Indian tribes, namely: (1) To the Tulkepaia, a tribe of the Yuman stock settled in 1875 on San Carlos reservation, Arizona. (2) To the Eoyotero Apaches, an Athapascan tribe. (3) To the Pinal Apaches of the same stock. (4) To a mixture of Yavakai (Yuman) men and Pinal women who have intermarried. The name has been especially applied to the last-mentioned body, who formerly occupied Tonto Basin and the Pinal Mountains of central Arizona, whence some 500 of them were removed to the Rio Verde reservation and later to the San Carlos reservation. They number about 700, and speak a mixed Yuman-Athapascan language.

TONTY, tŏn'tē, or **TONTI, Henri de,** Italian explorer: b. about 1650; d. Fort Louis (Mobile), September 1704. He was a son of Lorenzo Tonti. He entered the French army, served also in the navy, and in 1678 came with La Salle (q.v.) to Canada, went with him into the Illinois country in 1680, undertaking the first civilized occupation of that region, and was placed in charge of Fort Crèvecœur, a little below Peoria, where La Salle left him. In 1681 he joined La Salle at Michillemackinac, and with him descended the Mississippi to its mouth. Subsequently he was in command at the stronghold on «Starved Rock,» called by La Salle Fort Saint Louis, and in 1688, after La Salle's death, unsuccessfully attempted the rescue of the French colonists left in Texas. «There are very few names in French-American history,» says Parkman, «mentioned with such unanimity of praise as that of Henri de Tonty.» He wore a metal hand with which he so effectively disciplined the Indians on occasions that they thought him a great medicine man. Consult French, 'Historical Collections of Louisiana' (Vol. I, 1846); Parkman, 'The Discovery of the Great West' (1869; new ed., 1898).

«TOO PROUD TO FIGHT,» an expression used by President Wilson in the course of an address delivered to 4,000 newly-naturalized American citizens in Convention Hall, Philadelphia, on 10 May 1915. Torn from its context, this now historic phrase accumulated a large amount of more or less intentional misinterpretation. The sentence immediately following it contains the real gist of the President's meaning: «There is such a thing as a man being too proud to fight. There is such a thing as a nation being so right that it does not need to convince others by force that it is right.»

TOOELE, Utah, county-seat of Tooele County, on the San Pedro, Los Angeles and Salt Lake and the Tooele Valley railroads, 35 miles southwest of Salt Lake City. The industries include a large smelter, a flouring mill, saw mills and a creamery. It has a Carnegie library. Pop. about 3,000.

TOOKE, John Horne, English politician and philologist: b. Westminster, 25 June 1736; d. Wimbledon, 18 March 1812. He was educated at Westminster and at Eton, whence he was removed to Saint John's College, Cambridge. In 1756 he entered himself at the Inner Temple; but in 1760 he took orders. He was a warm opponent of the American war, and was prosecuted for sedition for the wording of a resolution by which the Constitutional Society voted £100 to the widows and children of the Americans «murdered by the king's troops,» in the battle of Lexington. For this obnoxious paragraph he was tried at Guildhall in 1777, and sentenced to a year's imprisonment and a fine of £200. In 1780 he published a keen review of Lord North's administration, in a pamphlet entitled 'Facts,' and in 1782 a 'Letter on Parliamentary Reform.' It was in 1782 that he took the name of «Tooke,» being previously known as John Horne. This came about through his being named as heir to William Tooke, a wealthy gentleman of Surrey. In 1786 he published in an octavo volume his work entitled 'Epea Pteroenta' (Greek for 'Winged Words'), or the 'Diversions of Purley.' In 1801 he accepted the seat for Old Sarum. His political life closed with the dissolution of Parliament in 1802. Tooke possessed considerable learning. His 'Epea Pteroenta' is original and ingenious, and has exercised considerable influence on the subsequent development of philological investigation.

TOOLE, John Lawrence, English comedian; b. London, 12 March 1832; d. Brighton, 30 July 1906. He was educated at the City of London School. After serving for some time as a wine-merchant's clerk he took to the stage, and made his first apperance at the Haymarket in 1852. He then played with great success in Dublin, Belfast, Edinburgh and Glasgow, and ultimately became a popular favorite everywhere. In 1880 he began the management of the Folly Theatre, London, which he afterward reconstructed and named after himself. In 1874 he visited America, in 1888 he published his 'Reminiscences' and in 1890 made a successful tour in Australia and New Zealand. He was one of the most popular actors on the stage, inimitable in his personation of semi-pathetic, semi-ludicrous characters. Among his most successful parts were Paul Pry, Caleb Plummer in the 'Cricket on the Hearth,' and Uncle Dick in 'Uncle Dick's Darling.' One of his latest parts was that of Walker in Barrie's 'Walker, London.'

TOOLE, Joseph Kemp, American lawyer and State executive: b. Savannah, Mo., 12 May 1851. He removed to Montana, became established as a lawyer in 1870, and served two terms as district-attorney. He was a member of the Territorial legislature in 1879, and of Congress, 1884–88. He was elected to the Constitutional Convention in 1889, was the first governor of the new State of Montana, 1889–93, and was re-elected governor in 1900 and 1904 but resigned 1 April 1908; and retired into private life.

TOOLS. The almost innumerable variety of mechanical appliances and devices which are included under the general term «tools» may be primarily classified into three important groups according to the nature of the material worked upon: (1) Wood-working tools; (2) Metal-working tools; and (3) Masonry-work tools; each of which include special forms of hand tools and machine tools which may be still further subdivided according to the class of work accomplished with their aid, or according to the character of the machines in connection with which they are employed.

Wood-working Tools.

The small tools used in wood-working are those mainly employed in carpentry work and consist of the various forms of «guiding» tools, «holdings» tools, «rasping» tools, «edge» tools or «cutting» tools, «boring» tools, «striking» tools and «chopping» tools.

The machine tools include the various forms of lathes, borers, shapers and slotters, equipped with suitable accessory devices such as cutters, drills, etc., according to the purposes for which they are used in turning, boring, drilling and other kinds of work in wood. The machine tools are always operated by power and in recent years a good many hand tools, as drills, are power-driven.

The guiding tools comprise the following named devices:

Chalk-line.— This consists of several yards of light cord wound upon a wooden reel. The cord is well rubbed in with chalk or with charcoal and is used for the purpose of making marks where cuts have to be made.

Rule.— This is a thin, flat, narrow strip of hard wood, ivory or metal, frequently two feet in length, and graduated or divided on both sides by a series of lines at right angles to the edge of the strip into inches and tractions of an inch, such as halves, quarters, eighths, twelfths, sixteenths and thirty-seconds.

Straight-edge.— This consists of a long, flat strip of hard wood, or of bright hard steel. Straight-edges range from four to six feet in length and from two to four inches in width. When they are made of wood, well-seasoned material free from winding is essential, and a metal edge is commonly attached, and when made of steel they are often nickel-plated in order to prevent them from rusting. They are used for ruling and marking straight lines.

The Squares or Try-squares.—A square usually consists of a wooden stock or back into which a steel blade is fitted at right angles and secured by screws or rivets. It is used for marking-out work at right angles. Squares vary in size from 3 to 30 inches. Sometimes they are made entirely of plain or of nickel-plated steel and have scales engraved on their edges.

Spirit-level consists of a glass tube partially filled with a quantity of spirit so as to allow of the existence of an air-bubble about half an inch in length within the tube. This tube is enclosed in a framework of hard wood the edges of which are perfectly level and true and parallel to the axis of the tube. It is protected on the most important sides, the edges, by metallic facings and is provided with a sight-hole either on the top or at the side through which the movements of the bubble may be observed. Spirit-levels range in length from 8 to 48 inches and are used for the purpose of ascertaining whether the surface of a piece of work or the portion of a structure is truly horizontal or truly perpendicular.

Plumb-level.— This is a cord attached to the exact centre of the upper end of a vertical straight-edge. A weight suspended from the lower end of the cord swings freely in a pear-shaped hole near the lower end of the straight-edge. A straight line is marked on the straight-edge from the centre of the pear-shaped hole to the point of attachment of the cord. In testing the perpendicularity of a surface, one edge of the straight-edge is placed against the surface under test and the coincidence of the cord with the line marked on the straight-edge is carefully noted.

Gauges.— Three common kinds of gauges are used in carpentry work — the «marking» gauge, the «cutting» gauge and the «mortise» gauge. The marking gauge consists of a head or block which slides along a shank about nine inches long. A spike is inserted near the end of the shank and the movable head is provided with a screw or a wedge by which it may be fixed at any required distance from the spike. It is used for the purpose of making a mark on a piece of wood parallel to an edge which has been previously straightened and along which the head of the gauge is guided while the spike inflicts the mark. It is very useful in dressing several pieces of wood to exactly the same breadth. The cutting gauge is similar to the marking gauge in all respects with the exception of the spike which is replaced by a thin steel plate. This plate passes through the shank and is held in place by a set-screw and is sharpened on one edge so that it is capable of cutting either with or across the grain. It is used for gauging dovetailed work and for cutting veneers to equal breadths. The mortise gauge is also similar to the other two gauges but it is provided with two spikes, one fixed and the other movable and capable of being adjusted at different distances from the fixed spike by means of a set-screw. It is used for the purpose of gauging mortise and tenon work. Compound gauges consisting of combinations of cutting and marking gauges or of marking and mortise gauges are also commonly used for the purposes designated.

Bevels.— These are made somewhat like the squares, but with the exception that the blades are attached to the stock by a pin which permits of their being set at any angle other than a right angle, and held in such position by a thumbscrew; they are used for the purpose of marking lines at such angles to the first side of the piece of work. In some forms the blade is slotted through a part of its length and is called a «sliding» bevel. Others such as the «boat-builder's» bevels have two brass blades, one at each end of the stock, while in the «protractor» bevels the sliding arm works through a semi-circle graduated into degrees.

Mitre-box.— This is a device for guiding a saw so that it will cut at some regular angle, as 45 degrees. In its simplest form it is a rectangular box composed of two vertical sides fastened to the bottom. A saw-cut made at an angle of 45 degrees through the sides guides the saw when it is employed to cut a piece of wood such as a picture molding placed in the mitre-box. Other cuts than those at an angle of 45 degrees may be made in the same box by cutting the guiding cuts at the required angles through the sides of the box. The most convenient form of mitre-box for cutting a wide series of angles is one provided with movable guides which may be readily set at the required angles. As a rule, the mitre-edges of the moldings are left rough from the saw so as to make the glue adhere more firmly, but where sawed mitre-work requires to be planed smooth it is planed up with a «shooting-board» which consists of two pieces of wood screwed together so as to form a step, on the upper one of which two strips of wood are screwed at right angles to each other. These strips act as guide-bars against which the piece of molding to be mitred is held and then planed off on the edge of the step.

Compasses and Calipers.— These devices are made of metal and are employed for the purpose of taking dimensions such as the inside and outside diameters of pipes and other cylindrical work that cannot be taken accurately with a rule. A compass consists of two legs which are movable about a sector joint. In the form called a «wing-compass,» it is provided with a metal arc and a set-screw attachment which permits of its being set to correspond with a definite measurement and remain so set without variation until that particular measurement is no longer required. Compasses are also used for striking-out circular figures.

Calipers are termed «inside» and «outside» calipers according to the character of the dimensions taken by their aid. Inside calipers are made with straight legs which are bent around only at the point and are used for measuring internal diameters. Outside calipers are made with bowed legs and are used for taking measurements of external diameters. «Combination» calipers are an improved form in which the legs are pivoted near the middle point, thus making four movable ends, two of which are bowed and are used for taking outside measurements, and the other two straight and applicable to the taking of inside measurements.

Trammels.— These are appliances in the form of beam-compasses in which the heads slide along a straight bar to which they may be tightened by set-screws. The heads are made either of brass or of hard wood, the former being preferable, and steel points are inserted into the bodies. They are employed for the purpose of taking measurements and for striking arcs which exceed the capacity of the ordinary compasses.

Caliper-rules and Caliper-squares.— The caliper-rule consists of a short steel rule, a portion of which is attached to a closely-fitting slide which may be drawn out until the object to be measured is embraced between the opposing portions of the rule. As both the rule and the slide are graduated into minute fractions of an inch, the thicknesses of the objects measured can be read off directly from the dimensions on the slide. The caliper-square is a square, one elbow of which is fitted with a caliper-rule.

Bell Centre-punch.— This is a useful little device, by the aid of which a square, round, oval or triangular article may be instantaneously and accurately centred for the purposes of drilling and turning. It consists of a punch which is enclosed within a tube the lower end of which is expanded or tapered into the shape of a bell. This tapering mouth adapts itself to bars of different diameters, and when dropped over the end of a bar of any cross-section whatever ensures the marking of the exact centre of the bar by the point of the punch.

The holding tools are represented by the various forms of pincers, vises and clamps.

Pincers.— These consist of various forms of implements shaped somewhat like tongs and are used for the purpose of drawing nails from timber. They are made of iron and faced with steel in the jaws. The faces are made large and nearly flat so as to afford great power of leverage.

Vises.— These are made in a great variety of forms and sizes, the most useful of which are those with parallel movement in the jaws. The ordinary vise consists of a pair of steel-faced jaws one of which is capable of being moved by a screw or by a lever, while the other is fixed rigidly. The improved forms are provided with swivel-bases and swivel-jaw attachments, which enable them to grip the work in any position that may be required for convenience in working. These appliances are usually attached to a work-bench and are used for holding or gripping pieces of work which require to be held firmly, but which have not sufficient weight in themselves to remain stationary or immovable under the operation of the tools. The vise-jaws are usually steel-faced. In fitting them to a vise they are first screwed to the wrought-iron backing and serrated while untempered; they are then removed and hardened and subsequently screwed back into place on the backing. In the smaller forms the steel-jaws are usually welded to the backing. In the form commonly known as the «taper» vise, a loose jaw-piece rounded on the back and capable of movement in a corresponding hollow seating is attached to the fixed jaw. It affords a slewing movement by which the vise may be adapted to different angles for holding various forms of tapered work. The vise-claws or vise-clamps are simply angle strips of lead, brass or copper, which are placed against the jaws in order to prevent the bruising of delicate pieces of work by the serrations on the hard-steel faces.

Clamps.— These comprise several forms of appliances for holding together pieces of work in position for nailing and screwing or for tightening up the joints in glued work in order to allow sufficient time for the glue to harden. An ordinary form consists of a long iron bar and two brackets which slide thereon. One of the backets is capable of being moved freely to any point on the bar while the other is actuated and its amount of travel limited by a screw which is attached to the end of the bar and operated by a lever handle. The bar is provided with a series of holes along its length for receiving the iron bolts by which the freely-sliding bracket may be held stationary at any desired point. Some of the other useful forms are the adjustable «screw-clamp» and the «corner-clamp,» the latter being a very useful device for securely gripping two sides of a picture-frame while they are being nailed or glued together.

The rasping tools comprise the various forms of saws, files and rasps.

The Saws are an important class of tools employed for cutting and dividing substances. In general, the saw may be defined as a tool having a serrated blade and furnished with a handle or frame by means of which it is operated either by hand as in the case of the hand-saws or by belting as in the case of the power-driven saws. The saw-blade or saw-plate is usually made of the best tempered steel and the form, length and pitch of the teeth are designed and made to suit the class or character of the work performed and the nature of the material worked. The various terms used for describing the principal parts of a saw may be briefly defined as follows: «space,» the distance between the points of two adjoining teeth. «Pitch» or «rake,» the inclination or angle of the face of a tooth. This varies from 65 degrees to 70 degrees for cutting soft woods and from 80 degrees to 85 degrees for cutting hard woods. The corresponding «relief-angle» or the angles formed by the base and top of the tooth varies from 45 degrees to 50 degrees for soft woods and from 65 degrees to 70 degrees for hard woods. «Gullet» or «throat,» the depth of the tooth from the point to the root. «Gauge,» the thickness of the saw-blade, usually determined by the wire-gauge. «Set,» the amount of lateral inclination given to the teeth to one side or the other of the plane of the blade for effecting a clearance of the sawdust. «Points,» the number of teeth points to an inch, taken as a unit in estimating the coarseness or fineness of a saw. The teeth of cross-cut saws are usually formed to cut both ways. Saw teeth are designated by various names such as «peg» teeth, «M» teeth, «half-moon» teeth, «gullet» teeth, etc., according to their peculiar form. The various kinds of saws commonly used by wood-workers are the «hand-saws,» the «back-saws,» the «frame-saws» and the «pad-saws.» The «pit,» «deal,» «frame,» «band» and «circular» saws are mostly used in connection with the production of lumber and sawmill-work. See SAWS AND SAWING in this Encyclopedia.

Files and Rasps.— These comprise a class of tools having surfaces covered with sharp-edged furrows or teeth, which are employed for removing particles of wood, metal or other material by the process of abrasion or the cutting action of a multitude of fine points. They are made in a vast number of shapes and sizes and of various degrees of fineness or coarseness to adapt them to various kinds of work and materials. A file differs from a rasp in that its furrows or teeth are made by straight cuts inflicted on its surface by a reciprocating chisel before the metal is hardened, either in a series of single cuts or crossed cuts, while the teeth of a rasp are a number of isolated projections raised on its surface by the pyramidal end of a triangular punch. See FILES AND FILE MAKING in this Encyclopedia.

Edge Tools comprise the various forms of chisels and gouges, the planes and a miscellaneous assortment of spokeshaves or smoothing tools and various appliances such as grindstones, emery wheels and oilstones, used for maintaining a sharp cutting-edge on the various tools.

Chisels and Gouges.— The essential principle of these types of cutting tools is that of the wedge. The chisel in its simplest form practically constitutes the slice of an axe, but as its action or movement is the result of the force applied to it by the blows of a mallet or hammer, the eye of the axe is replaced by a suitable device for receiving the blows. When the element of thrust enters into the operation of a chisel, as in the cases where it is used by the simple pressure of the hand, its action passes into that of the plane iron. Chisels are specifically defined as «chipping,» «cross-cut,» «firmer,» «pairing» and «mortise» chisels. The firmer chisels are the ordinary short chisels used by wood-workers and are so designated in order to distinguish them from the paring chisels which are usually about twice the length of the firmer tools and are almost exclusively used by patternmakers. Paring chisels are seldom driven with the mallet, but are actuated by hand pressure alone. They are made in width ranging from one-fourth inch to two inches. The mortise chisel is a stout wood-workers' chisel which is driven with a mallet and used for cutting mortises where percussion and leverage are rendered necessary. The gouges are forms of paring and firmer chisels which have curved cross-sections. The cutting-edge of the paring gouge is formed by grinding its inner face and that of the firmer gouge by grinding its outer face. Gouges vary in width from one-eighth inch to two inches. The paring gouge differs from the ordinary firmer gouge in its increased length. It is never driven with the mallet, but is applied with a thrusting motion of the hand and is used chiefly by patternmakers for cutting the various curved outlines of their work. It will be observed, that as a rule, the chisel cannot be satisfactorily used over a surface wider than itself, and, therefore, the gouge was devised in order to obtain a tool of greater utility for that purpose. In practice this advantage is partially realized, but there still remains quite a tendency on the part of the gouge to follow the grain of the wood instead of cutting through the fibres at a very slight inclination. All gouges are held and used in the same way as a paring chisel, but if any occasion demands the driving of a gouge with a mallet, it should always be held in a perpendicular position.

Spokeshaves or Drawing Knives are essentially two-handed blades which can only be used by being pulled toward the operator. The general form consists of a long, narrow, chisel-edged blade the ends of which are attached to two handles which stand at right angles to the blade. These handles are of wood and the «tangs» into which the ends of the blade are prolonged are bent around at right angles to the blade and pass right through the handles and are riveted over brass plates at their ends, in order to prevent the blade from being drawn out of the handles when it is drawn toward the workman against the resistance of the wood. These tools are used for cutting thick and heavy chips off the rough edges of boards so as to decrease the amount of the work required in the planing operations and they are also used by patternmakers for the cutting of sweeping curves or «sweeps» in work where great accuracy is not essential. Router types are provided with cutters of varying forms and are effectively used for chamfering, rabbeting and other similar purposes.

Planes.— In its simplest form the plane consists of a chisel-shaped plane-iron, so-called, though made of steel, placed at an angle in a «stock» or box of wood or metal in such a way that the cutting edge projects slightly through the bottom of the box. It derives its value from the guidance imparted to the cutting edge by the sole or bottom of the box. The plane is operated by being pushed forward, over the surface of the material being worked, so that the cutting edge bites into the fibre and removes a thin shaving which slides upward along the upper side of the plane-iron and is thus discharged from the hollow of the box. The depth of the cut or the thickness of the shaving removed may be regulated by raising or lowering the plane-iron, which is usually held in place by means of a wedge or by a screw, and is, therefore, capable of being adjusted. The plane-irons are made both single and double. In the latter case, the back-iron is introduced for the purpose of breaking the shaving so as to reduce the amount of cumulative indrawing force due to the continuity of the fibre of a long shaving. Planes in which double plane-irons are used are called «built-up» planes. There are at least a hundred different kinds of planes in use at the present time, but all of them may be grouped into three general classes — the «jack-planes,» the «trying-planes» and the «smoothing-planes.» The jack-plane is the first plane used for roughing down the timber received from the hands of the sawyer or from the saw-mill. The cutting-edge of its plane-iron is more curved than those of the other planes and consequently takes coarser and narrower shavings. The trying-plane is used after the jack-plane for producing the greatest accuracy attainable in the surfacing of wood by hand. It is usually about 22 inches in length and carries a plane-iron about two and one-half inches in width. The cutting-edge is sharpened perfectly straight transversely, and this, combined with the length of the plane, enables the workman to produce very true surfaces by its use. The smoothing-plane is a small plane used for imparting a smooth finish to surfaces in work where extreme accuracy is not essential. It is made about eight inches in length and is designed to carry plane-irons ranging from one and three-fourths to two and one-fourth inches in width. Some of the more useful and important special forms of planes are the «rabbet» or «rabbeting» plane, employed for making window frames and other similar work in which a rabbet or recess is required to be cut for the reception of the edges of a glass plate or other material; the «plow,» employed for cutting a deep groove along the edge of a board for the reception of a corresponding tongue formed along the edge of an adjoining board, and the «stop-chamfer» plane, employed for cutting any chamfer or bevel-edge ranging from one-eighth inch to one and one-half inches in size, with a constant angle.

Grindstones, Emery Wheels and Oilstones.— The sharpening of the cutting-edges of chisels and plane-irons is performed first on a grindstone or on an emery wheel and then finished to a fine edge on an oilstone. Grindstones are natural stones which are turned into circular form and are made of varying diameters. They are usually arranged to revolve in troughs containing water, but they ought not to run actually in the water as that would tend to soften them and cause them to wear unequally. The water should be fed onto them from a drip-can. They are revolved by a crank-handle attached to the axle and make about 100 revolutions per minute when used for grinding ordinary tools. Various forms of rests or supports have been devised for holding the tool during the process of grinding, but in the case of wood-working tools they are seldom used, the workmen usually preferring to hold the tools by hand against the edge of the rotating stone. Grindstones are «trued» or «turned-up» by hand by means of a pointed bar of steel which is constantly rotated during the operation so as to always present a new cutting-edge to the stone and they are «trued» mechanically by means of a threaded roller of steel which is clamped in a frame and allowed to rotate against the surface of the stone. Such appliances are called «grindstone truers.» Emery wheels are similar in appearance to grindstones, but made of powdered emery cemented together or of emery cemented to a wooden centrepiece. The cementing material usually employed is a silicate insoluble in water and the wheels are usually made in about 10 degrees of coarseness. They are usually of smaller diameter than grindstones and operated at a higher rate of speed. Emery itself is a species of corundum composed of oxide of iron, alumina, silica and a small proportion of lime. The oilstones, sometimes called «hones,» are essentially fine-grained natural stones which are used for producing the final edge on cutting tools by the process of abrasion, with oil instead of water to assist the process. They are usually set in wooden stocks and provided with covers to protect them from dust and grit. The principal varieties are the Turkey, the Charnley Forest, the Arkansas, the Grecian and the Washita stones. As a general rule, oilstones will wear away the most in the middle and become hollow both in the direction of their length and breadth. Sometimes, as in the case of the sharpening of jack-plane irons, this hollowing out is somewhat of an advantage as it imparts a desirable curvature to the cutting edge, but when it extends to an inconvenient degree the surface of the stone is leveled by being rubbed on a flat sandstone or on an emery slab. Gouges and bead-planes are usually set or sharpened by means of oil-slips or thin slips of oilstone about six inches long and two inches broad and ranging from one-eighth inch to one-half inch in thickness, the edges of which are rounded in a transverse direction to fit the hollow faces of the tools.

Boring tools for wood comprise the various forms of awls, gimlets, augers, bits and braces and the drills.

Awls or bradawls are the simplest forms of boring tools and are used for preparing holes for the admission of nails and screws. In its ordinary form the awl consists of a small steel rod one end of which is fastened to a wooden handle and the other end double-bevelled to a sharp V-shaped edge by which the fibres of the wood may be compressed and parted so as to form a hole without producing chips and dust. The greatest drawback in the ordinary forms is the tendency of the steel rod to pull out of the handle when the tool is withdrawn from the hole it has made in the wood. This is especially the case when working in hard woods. In the superior forms this fault is remedied by the use of a hollow handle which contains a number of awls of different sizes, each of which may be fastened to the handle by means of a screw-nut.

Gimlets are of awl-form plus a screw. It consists of a small steel rod, one end of which is attached to a wooden handle which forms a T with the rod, and the other end is shaped into the form of a screw. This end consists of a point in the form of a taper screw and a spiral groove which extends partway of the stem or body as in the case of the «twist-gimlets,» or the body may be hollowed out into a nearly semi-cylindrical shell as in the case of the «shell-gimlets.» The commonest forms are called «spikes,» while other forms are designated as «triple-twist» gimlets, «auger» gimlets, «patent-twist» gimlets and «brewers-twist» gimlets, according to the shape of the spiral body. A complete assortment of these tools are usually required by a wood-worker.

Augers are merely large gimlets. They are made in both the twisted and the shell forms and are operated by both hands by means of a wooden bar thrust through the eye at the handle end of the stem. Their sizes increase one-eighth-inch at a time from three-eighths-inch to two inches in diameter.

Bits and Braces.— The bits comprise the various forms of boring tools such as «centres,» «shells,» «gouges,» «countersinks,» etc. They are actuated by the «brace» or «stock.» These tools were developed in order to overcome the faults inherent in all forms of awls, gimlets and augers, due to the interruption of the continuous rotation of those tools necessitated by the changing of the position of the hands and by the limited amount of pressure applied to the tool. The stock or brace consists of a crank, one end of which is provided with a round head for receiving the pressure of the breast of the operator and the other end recessed for the reception of the bit. In the earlier forms the bit was secured in the receiving end of the brace by means of a thumb-screw which engaged a notch near the end of the stem and constituted the weak point of the compound tool. This defect has been remedied in the later forms by the use of various kinds of expanding devices or expanding-chucks which adapt themselves to all shapes and sizes of stems and hold the bits securely and truly in place. The centre-bit comprises the centre-point, nicker and cutter attached to a shank. The nicker and the cutter are actuated by the brace and rotate about the centre-point. It is used for boring large and deep holes. The countersinks are made in a great variety of forms and are designated as «snail-horn,» «rose-head» and «flat-head» according to the shape of the cutting point. In wood work they are employed for enlarging the entrances of holes when it is desired to let the heads of screws or bolts lie completely below the surface of the wood. Some of the other useful forms of bits actuated by the brace are the «screw-driver» bit, the shank end of which is square-tapered to fit the socket of the brace and which being turned with the brace is quicker in its action than that of a hand-worked screw-driver; the «taper» bit for boring funnel-shaped holes; the «shell» bit, the cross section of which is composed of a convex and concave curve roughly semi-circular in form; the «nose» bit, a shell bit provided with a nose or lip at the cutting-point for the withdrawal of the core from the wood; the «spoon» bit, the cutting-edge of which is formed in the shape of a parabola and, therefore, does not draw out the core as effectually as the nose bit; and the «gouge» bit, the cross-section of which is similar to that of the gouge and is simply rounded at the cutting-point without the provision of a nose or lip. In the ordinary forms of the compound tool the brace is rotated through complete revolutions, thus preventing the boring of holes or the driving of screws in one side of a corner at a distance any closer to the adjacent side than that which is equal to the radius of revolution, but this shortcoming of the tool is remedied in the hatchet brace in which the brace acts as a lever which moves the bit around and at the same time feeds it forward by means of a ratchet and click actuating a square-threaded feed-screw, as the brace is moved back and forth through partial revolutions.

The striking tools comprise the various forms of hammers and mallets.

Hammers.— Ordinarily, a hammer consists of two parts — the iron or steel hammer-head, and the shaft or handle of wood which is driven into a hole in the «centre of mass» of the hammer-head. The angles at which the handles are attached to the heads vary greatly on account of the variations in the position of the centre of gravity of the head relatively to the line of the penetration of the handle, and also on account of the various convexities of the faces of the hammer-head. The form of the «pane» or the narrower or smaller end of the hammer-head also varies greatly in the hammers used for different purposes. When of hemispherical form as in the engineers' hammers, it is called a «ball» pane; when it is made in the form of a narrow, round-edged ridge placed at right angles to the axis of the handle it is called a «cross» pane; and when the ridge runs longitudinally it is called a «straight» pane. In the claw-hammer the pane is curved upwards toward the handle and is divided by a V-shaped groove, and the head is usually attached to the handle by means of side flanges. It is very useful for drawing nails. The hand hammers used by wood-workers range in weight from one-half ounce to 10 pounds. The weight of the head and the balance of the head in the handle are the most important considerations controlling the suitability of a particular hammer, for if the handle is too light for the head it will break off.

Mallets.— These are forms of hammers in which the metal heads are replaced by wooden blocks. They are practically heavy wooden hammers which are used for delivering blows on the handles of chisels and gouges in order to avoid the risk of smashing and splitting them down as is usually the result when iron hammers are used for that purpose. Round-faced wooden mallets are used by molders for rapping patterns in order to detach the sand which adheres to them when they are drawn from the molds. Woodworkers' mallets are either square or round in form. The square mallets are about six inches in length and two by wood-workers range in weight from one-half inches in width. The round mallets are about five inches in length and three inches in diameter. The mallet-heads are usually made of hickory wood, and sometimes of lignum vitæ.

The chopping tools are the axes, the hatchets and the adzes. In each case they represent the combination of a striking tool and a cutting tool. In these tools the shape of the handle or helve and the manner in which it is attached to the blade is of the utmost importance in governing their effectiveness.

Axes and Hatchets are edged tools with handles used in chopping for rough cutting or splitting. They vary mainly as to the weight of the blade, to the shape or curvature of the handle and to the form of the cutting-edge. Axe blades range in weight from two to seven pounds. These blades are usually made by welding the hard tempered steel portion which forms the cutting-edge to the iron portion which contains the «eye» provided for the reception of the handle. The curved form of the handle is designed to counteract the influence of the force of gravity which tends to twist the blade downwards when the axe is used for chopping at various obliquities. The form of the cutting-edge, curved horizontally, and wedge-shaped transversely to the sides of the blade, is designed for the purpose of separating the groups of wood fibres successively, and for equalizing the pressure of the blow on each side of the blade. A hatchet is a light form of axe, with usually a nail-pulling groove back of the blade.

In the adze, the cutting edge stands transversely or at right angles to the handle, which is quite short. The entire outer face of the blade is made slightly curved, and its cutting-edge is formed by beveling from the inner face. It is usually employed for the forming of lengths of wood into curved shapes.

Metal-working Tools.

The almost innumerable variety of metal-working tools and the great variety of purposes for which they are employed make their classification into a series of general groups practically impossible within a limited space. In a general work they may be conveniently divided into various classes according to the character of the work to which they are applied. Such a method of classification would group the main body of metal-working tools under foundry work, forge shop work and machine shop work, the last named including all the turning, gear-cutting and toolmaking tools and appliances. The greater number of these are treated under their special headings in the several volumes of this Encyclopedia, and as in the case of the wood-working appliances, the various kinds of machines employed in the metal-working industries will be found specifically treated under the title Metal-working Machinery. The larger metal-working tools are known as machine-tools, including all those machines that operate cutting tools for shaping metal, as lathes, power-drills, boring-drills, shapers, milling machines and the like.

The elementary descriptions of the various forms of small tools such as the guiding tools, the holding tools, the rasping tools, the cutting tools, the drilling tools and the striking tools already given in connection with the wood-working tools will be found applicable to similar tools employed in metal working, subject, however, to the modifications demanded by the greater hardness of the material worked, and the greater accuracy of execution required in the finished products of some classes of metal work. In the main these modifications consist in the employment of finer and harder materials in the making of the tools, in the particular forms given to the cutting edges and in the methods by which the tools are applied in the execution of the work.

The guiding tools employed in metal work are quite similar to those already described, and comprise the various forms of rules, squares, straight-edges and calipers, all made of metal, and also the various forms of micrometer calipers with vernier attachments which are capable of measuring dimensions as small as 1-10,000th of an inch. These calipers are divided into two general classes — the «yoke» calipers and the «beam» calipers. In the former, the outer end of the shank of the yoke contains a split-nut which is employed for making adjustments for wear. For this purpose, the nut is closed onto the screw by being advanced on the stem toward the yoke. The shell or thimble on which the graduations are marked is attached to the end of the screw and rotates with it, and moves along over the shank. A speeding arrangement for rapidly advancing the screw is provided in the form of a knurled-nut in the yoke, which is also capable of contracting a bushing over the measuring stem so as to lock it in any desired position. The measuring point and the opposing anvil are carefully ground so as to make their faces perfectly parallel with each other. These micrometers are usually provided with a screw having 40 threads to the inch, with the barrel graduated to 10ths and 40ths of an inch. By this arrangement one revolution of the screw advances the thimble one division on the barrel, equal to one-fortieth of an inch, and as the circumference of the thimble is divided into 25 equal parts, one-twenty-fifth of one revolution of the screw advances the measuring point one-twenty-fifth of one-fortieth, equal to one one-thousandth of an inch. By the aid of the vernier attachment applied to the barrel measurements as small as one ten-thousandth of an inch are readily obtained.

Gauges and Indicators.— These tools are employed for indicating the sizes of wire, machine-screws, drills and plate thicknesses. Various systems of gauges are employed, in all of which the dimensions are purely arbitrary. The American or Brown and Sharp gauge was adopted to produce a gauge to overcome the irregularities in spacing of the Birmingham gauge. In this gauge the dimensions increase by regular geometrical progression, the largest dimension No. 0000 being equal to 0.46-inch and the next smaller dimension, No. 000, being obtained by multiplying 0.46 by the constant .890522, each smaller number being the product of the preceding number and the constant. Gauges for indicating the gauge of wire or plates are of two forms — the angular and the notch gauges. Other forms of gauges are the «centre» gauge which is used for gauging lathe and machine centres in turning and grinding work; the «screw-thread» gauge used for grinding threading tools; the «screw-pitch» gauge used for determining the pitch of screw threads; the «depth-gauge» used for measuring the depth of holes and recesses; the «scratch» gauge used for ruling lines parallel with the edge of a piece of work and several forms of «surface» gauges which are principally used in determining the parallelism of the surface of a piece of work with the machine table, housing or other plane of reference. They are also used in testing, erecting and in the setting-up work on machine tools.

Test indicators are a class of tools or instruments used for determining small irregularities in the accuracy of cylindrical surfaces and small variations from the true rotation of such surfaces. They are also used in determining the inaccuracies of a plane surface and in measuring small amounts of end or lateral motion such as the end-motion of a spindle. They are of two types — those which merely indicate the existence of the irregularities and those which give a reading or measurement showing the exact amount of the errors.

Some of the other small tools indispensable to the metal worker may be briefly summarized as follows:

The various forms of «hack-saws» used for severing purposes. They are made of hardened steel to cut metal and mounted in a light frame and may be operated either by hand or by some form of power. Their blades are usually made with 14 teeth to the inch for general work and with 25 teeth to the inch for cutting tubing and thin metal.

The «monkey-wrench» and other forms of wrenches used for screwing and unscrewing the nuts of screw-bolts, etc.

The various forms of «drills» and especially the modern «twist-drill» which is universally used at the present time and which has completely supplanted the old flat forged drill which for many years held the first position as a tool for producing circular holes in metal.

The «reamers» and «broaches,» which comprise a class of fluted tools used for finishing and truing cored or drilled holes. They are solid when used in a socket or with a wrench and shell or hollow when bored out to fit a mandrel.

The «screw-threads,» «taps» and «dies,» which, according to their use, may be divided into two classes — those used for fastenings and those used for communicating motion. There are three forms of screw threads used for fastenings — the «V» thread in which the sides make an angle of 60 degrees with each other and in which the top and the root are sharp; the «United States standard» thread which is similar to the «V» thread with the exception that the top is cut off and the bottom filled in; and the «Whitworth» or «English standard» thread in which the top is rounded off and the root filleted in and in which the sides form an angle of 55 degrees with each other. There are also three forms of screw-threads employed for communicating motion — the «square» thread, the «trapezoidal» thread and «Powell's» thread.

The top is used for producing internal threads and the die is employed for cutting external threads. They are of two kinds — those operated by hand and those operated by power-driven machines. Hand taps are made in sets each of which comprise three taps — the «taper-tap,» the «plug-tap» and the «bottoming tap.» The taper-tap is parallel on the point for a distance equal to one-fourth the diameter of the tap and this point is made the diameter of the roots of the teeth and corresponds to the correct size of the hole to be tapped so as to produce a full thread. In the plug-tap the first three teeth are tapered off and in the bottoming-tap the teeth extend full to the point. The taper-tap is used for starting a thread, the plug-tap for extending it nearly to the bottom and the bottoming-tap for finishing the full thread to the very bottom of the hole.

The dies may be divided into two general classes — those which have to be passed over the work several times in order to produce a finished thread and those by which a finished thread is produced at a single cutting. In the former, the cutting-dies are held in a stock and are capable of being separated so as to permit of their being passed over the work and then closed, by means of a set screw, an amount sufficient to enable them to cut a full thread. In the latter, when they are not of the screw-plate type, the «chasers» or «cutters» are held radially in a cast-iron «collet» surrounded by a wrought-iron ring. These dies are capable of being adjusted to compensate for wear. The bevelled outer ends of the chasers fit into corresponding bevelled grooves in the wrought-iron ring so that when the ring is forced down the chasers are moved toward the centre. A great variety of self-opening and adjustable dies are also used for machine threading.

Masonry Work Tools.

The masonry work tools may be conveniently divided into two general classes — stonemasons' tools and bricklayers' tools. Those employed by either of the two classes of workmen are neither numerous nor intricate in design. The principal tools of the stonemason are the saw, the mallet, the scrabbling hammer and the various forms of chisels designated as the «inch-tool,» the «boaster» and the «broad-tool,» which are distinguished by their size, the first being one inch, the second two inches and the third three and one-half inches in width. In the work of stone cutting, the preliminary operations are performed by a small chisel called the «point» and the finishing work executed by the use of the others in turn according to their size. The principal tools of the bricklayer are the various forms of trowels, the plumb levels and the bricklayers' hammers. For further information relative to the various forms of stone-cutting saws, see Saws and Sawing; Stone-Cutting and Dressing; and also the articles under the titles Files and File Making; Metal-working Machinery; and Wood-working Machinery in this Encyclopedia.

TOOMBS, Robert, American lawyer and statesman: b. Wilkes County, Ga., 2 July 1810; d. Washington, Ga., 15 Dec. 1885. He was the son of a Georgia planter, attended for one year Franklin College (now the University of

Georgia) and was graduated at Union College, Schenectady, N. Y., in 1828. In 1829 he studied law at the University of Virginia and in 1830, being under age, was admitted to the bar by special act of the legislature. Within 10 years he became one of the foremost lawyers of Georgia. In 1836, when the Creek War broke out in Alabama, he raised a company of volunteers and served as captain under Gen. Winfield Scott. In 1837–40 and 1842–43 Toombs was a member of the legislature and during this time became a leader of the State Rights Whigs of Georgia. From 1844 to 1852 he served as representative in Congress and was one of its best orators and debaters. In 1850 he was a prominent supporter of the compromise measures in the House. In 1852 with other Southern Whigs he refused to support Scott for President. After 1852, like Stephens, he acted with the Democrats. From 1853 to 1861 he was in the United States Senate. In 1854 he favored the Kansas-Nebraska Bill as carrying out the principles of the compromise of 1850. Immediately before the elections of 1860 Toombs lectured in the North on slavery. After the election of Lincoln he advised secession of the Southern States and made secession speeches in Georgia in December 1860 and in the United States Senate in January 1861, maintaining that in secession lay the only hope of security for the South. Georgia seceded 19 Jan. 1861 and Toombs withdrew from the Senate four days later. In March he was formally expelled. He was chosen to the Confederate Provisional Congress that met in Montgomery 4 Feb. 1861 and by a considerable minority was considered as a candidate for President. On 21 February he was made Secretary of State by President Davis. He opposed the firing on Sumter that began the contest of arms. Resigning September 1861 to become a brigadier-general in the Confederate army, he fought with distinction in the second battle of Manassas (Bull Run) and at Sharpsburg (Antietam). He resigned his commission in 1863 and in 1864 was made commander of the Georgia militia. He disapproved the policy of the Richmond administration and personally disliked Davis. With Vice-President Stephens and Governor Brown he headed the Peace Movement in Georgia in 1864, thereby doing much to weaken the cause of the Confederacy. In 1865, to escape arrest, Toombs went abroad, visiting Cuba, France and England. Returning in 1867, on the restoration of the privilege of *habeas corpus*, he soon amassed a fortune of $500,000 in the practice of law. In 1872 he was a member of the Georgia Democratic Convention and supported Horace Greeley for the Presidency. In 1874 the Georgia legislature passed a law providing that railroads should be taxed like other property. The railroads resisted, and Toombs, taking the case of the State, won the suit in the courts and collected all back taxes. For 10 years he continued the struggle to force the railroads to pay taxes and give proper service to the public and in 1877 secured the passage of a law providing for a board of railroad commissioners. Other Southern States have since passed laws modeled after the Georgia law.

By his enemies Toombs was considered extreme and intolerant — a «fire-eater.» His friends thought him a statesman of the first order and were disappointed that he made no higher mark. His hasty temper hindered his career in politics. In the army he was an able general, but not a disciplined subordinate. He belonged to the school of Jefferson in politics, believing in strict construction, State sovereignty and strong local government, with much liberty for the individual. His political theories were meant for times of peace, but could not stand the strain of war; consequently he was at variance with the Confederate administration from the beginning. As long as he lived Toombs never ceased to denounce the Reconstruction measures of Congress. His experiences from 1865 to the end of Reconstruction caused him so to dislike the United States government that he refused to ask for a pardon or to take the oath of allegiance and he never again had the privileges of citizenship. Consult Stovall, 'Robert Toombs, Statesman, Speaker, Soldier, Sage' (1892); Trent, 'Southern Statesmen of the Old Régime' (1897).

W. L. Fleming,
West Virginia University.

TOON, or TOONA, a tree (*Cedrela toona*) of the family *Meliaceæ*. It is a native of India and Australia, being found at altitudes of 4,000 feet on the Himalaya Mountains as well as near tide-level. In the former country it is one of the largest trees; in the latter, it often exceeds 150 feet in height and 18 feet in circumference. Hooker mentions a specimen in India 10 feet in diameter at five feet from the ground. The tree is cultivated for its timber, bark and flowers. The wood is soft, open-grained, easily seasoned and worked, little liable to warp and easily polished. The heartwood is reddish and resembles mahogany and veneers taken from the roots or where branches join the trunk are said to be remarkably handsome. The chief uses of the wood are in house-building, furniture-making, carving, etc. Under the names bastard cedar, bastard white cedar and Moulmein cedar the wood is an important export to English markets. The bark is very astringent and is used for making leather which usually is purplish from a dye also present. The flowers yield a reddish or yellowish dye which is in common use in India. A close relative of this tree, *C. sinensis*, is grown in the United States in streets and upon lawns. It resembles the ailanthus in hardiness and its graceful, feathery foliage, but is superior in regularity, denseness of growth and in the absence of disagreeable odor during the blossoming period. Several other species are cultivated in California and the Gulf States, but are not hardy in the colder parts of the country. See Mahogany.

TOOTH-BILLED PIGEON, a large fruit-pigeon (*Didunculus strigirostris*) of Samoa, formerly called «dodlet» under the erroneous impression that it was a surviving relative of the dodo. It is about 14 inches long, body rounded, beak orange, with the lower mandible deeply cleft into three distinct teeth near the tip. Head, neck, breast and abdomen glossy greenish black, rest of back, wings, tail and under coverts deep chestnut. It is now rare.

TOOTH-ORNAMENT, a decoration peculiar to mediæval architecture, consisted of four-leafed flowers, the centres of which project in a point. These are used in series, either in a continuous row or at slight intervals, and are generally inserted in a hollow molding. They are used in great profusion in the Early English architecture, forming one of its characteristic features, and in some of the richer suits of molding the flowers are very thick and the series is repeated several times.

TOOTH-SHELL. See DENTALIUM.

TOOTHACHE, a pain in a tooth or adjacent jaw, arising from various causes. The most common cause is decay of some portion of the tooth, admitting air to the nerve, which causes sharp pangs. If there is a considerable opening it is colloquially called «jumping toothache.» The pain may be stopped by application of oil of cloves on cotton and closing the passage that admits air; if oil of cloves is not to be had diluted chloroform on cotton is a good substitute; creosote is also used, especially in a gum styled toothache gum. But the pain and decay will usually continue unless the services of a dentist are sought. Decay in the root of a tooth often generates gas, which induces a pressure on the nerve, and consequent toothache. The remedy is to bore a small hole into the tooth and release the gas. If this is not done the gas forces itself through the gums, often with severe pain, resulting in a gum-boil. This is not a true boil, but a hole worked through the flesh by the pressure of the gas. When this finds a vent there is some relief, but a permanent cure involves treating the tooth by a dentist. Neuralgic toothache is a purely nervous variety, and may occur either in sound or carious teeth. It comes and goes suddenly in paroxysms, and is accompanied by little or no swelling. As a preventive against toothache the teeth should be kept scrupulously clean, and when they show symptoms of decay the services of a skilful dentist should be secured. The decay of a tooth is arrested by stopping or filling up the cavity.

TOOTHACHE TREE. See ARALIA.

TOOTHED HERRING. See MOONEYE.

TOOTHPICK, a small pick for removing substances lodged in the teeth. The ordinary toothpick is of wood about the size of a friction match, but longer and slenderer and pointed at one end or both. The use of wooden toothpicks has become very common in the United States and many millions of the tiny wooden slivers are manufactured there every year. The seat of this industry is in Maine, near the forests of white birch, which wood is chiefly employed in their making. The felling of «toothpick trees» is not a separate business but one incidental to the Maine lumbermen. After a tree has been felled the branches are lopped off and only the trunk is sent to the mills. There the bark is skinned and the naked trunk is cut by machinery into thin sheets of wood of the thickness of toothpicks and as wide as a toothpick's length. These sheets, known as «veneers,» are run through another machine which in one operation cuts them into toothpicks ready for shipment. Of the better grade of toothpicks large importations are made every year from Japan and from Portugal. The Portuguese toothpicks are made of orange-wood and are smaller but tougher, better shaped and more finely pointed than the domestic picks. The Japanese make their toothpicks from fine reeds, which they shave down to the thinness of paper, retaining the reed's strength and pliability. Metal toothpicks, as of gold, which were formerly common, are now little in demand since their use endangers the enamel of the teeth. Quill toothpicks, cut from the shaft of a hen's feather, are still considerably used.

TOOTHWORT. See DENTARIA.

TOOWOOMBA, too-woom'ba, Australia, a town of Queensland, in the southeastern part of the state, 100 miles by rail west of Brisbane, on an elevation known as the Great Dividing Range. It has a number of churches, two colleges and other educational institutions, and a fine new municipal building. There are flour-mills, saw-mills and a brewery, and in the neighborhood are vineyards. Pop. about 11,000.

TOP-MINNOWS, a group of small, robust minnows, represented by *Gambusia patruelis* of the brackish waters along the Atlantic Coast, which are distinguished by their habit of swimming and feeding near the surface. See MINNOW.

TOP-SHELLS, the *Turbinidæ,* a family of gasteropod mollusks, mostly tropical and oriental, in which the shell is usually turbinate or top-shaped, but may be pyramidal. It is generally nacreous internally. The operculum is horny, and may exhibit a spiral form. In the genus *Turbo* the shell is top-shaped with a rounded base. The whorls are convex, and the aperture is large, the operculum being calcareous. The genus *Trochus* also belongs to the top-shells. In the latter genus the shell is pyramidal and the base flattened, the operculum being horny. The common top is the *T. zizyphnus.* Others are the *T. versicolor,* the *T. imperialis* and the *T. niloticus.* After having been ground and polished to exhibit the nacreous inner layers, they are extensively sold as ornaments.

TOPAZ, a mineral having the composition of an aluminum fluo-silicate. It is not the topaz of Pliny and other early writers which was chrysolite (q.v.), the names having been interchanged. It generally crystallizes in orthorhombic prisms, colorless, white, yellow, or occasionally pale green or blue. Transparent topaz, in any of its tints, is a beautiful gem. The colorless variety much resembles diamond, and is sometimes sold for it, though its lower hardness (8) affords an easy test. What has been called the largest diamond in the world, among the Crown jewels of Portugal, is probably a colorless or «white» topaz. The yellow variety is most familiar, and is called «Brazilian topaz,» in distinction from «Oriental topaz» (yellow sapphire) and «false,» «Scotch» or «Spanish topaz» (yellow quartz). The «Oriental topaz» is much rarer, harder (9) and denser (about 4); while the «Spanish topaz» is cheaper, less hard (7) and lighter (2.65), the density of topaz being 3.4 to 3.6. It is also distinguished by its eminent basal cleavage. The favorite shade is wine-yellow or sherry-color. Both yellow and blue topaz fade and become white by weathering or exposure to light, and some yellow varieties can be changed to a pale pink by heating, yielding the so-called «burnt topaz» or «Brazilian ruby,» resembling the pale, or Balas, variety of ruby spinel (q.v.).

Topaz occurs usually in metamorphic rocks, like gneiss, but also somewhat in igneous rocks; it is frequently, though not always, associated with tin-ore. The principal localities are in Ceylon, Siberia, Japan, Brazil and Mexico. In the United States it occurs in large masses at Stoneham, Me., and Trumbull, Conn.; in crystals in Colorado and Utah. Fine topaz crystals, colorless and pale blue, have recently been found in San Diego County, Cal.

TOPAZOLITE, a variety of andradite garnet having a light yellow or pale grayish green color. The most beautiful specimens are found in the Ala Valley, Piedmont, Italy. They also occur in California.

TOPE, a Buddhist monument intended for the preservation of relics. The oldest monuments of this kind are spherical or elliptical cupolas, resting on a circular or rectilinear base, with an umbrella-shaped roof, and sometimes with a series of roofs of this form which develop into a spire, pyramid or other architectural ornament. In the interior is a cell or chamber for containing the box with relics; but in some cases no relics have been found, and it is supposed they have been buried underground. The Sanskrit name is *stupa,* mound, from which is derived thupa and tope, meaning top. The older topes are masonry mounds, the cupola top and ornamental roofs and spire forms being later developments for ornamentation. Some of them are of great architectural beauty, rising tier above tier, with a series of graceful «parasol» roofs, the limit of height being about 300 feet. But the typical construction is that of The Great Tope at Sanchi, in central India. This is a hat-shaped mound or dome 42 feet high and 106 feet at the widest point. The flat space on top was for the chhatra or umbrella-like apex, this being the royal emblem. This was like a substantial parasol, as if to guard the relics from the weather. The Great Tope is surrounded with a magnificently carved stone railing, leaving an elaborate ornamental entrance or gateway, over 30 feet high. The chamber or cell in which the relics were kept was generally built with an outer construction of masonry; often enclosing a bronze box, which again enclosed a silver cylinder or case and within this perhaps a casket of gold containing the relics which it was desired to preserve. The number of stones in the topes often indicate Buddhistic symbolism — three, seven and 13 being the numbers rich in meaning. Topes are common in the Orient and there are groups of conspicuous ones at Amravati, Sarnatti and Telelabad in Bengal, at Satdhara and Sonari in central India, at Abayagiri, Ruanwalli and Tuparamaya in Ceylon, etc. Relics of kings and great men were thus cared for, much as we build statues and monuments to-day. See DAGOBA; PAGODA.

TOPEKA, Kan., city and county-seat of Shawnee County, capital of the State and the third largest city in the State, on both banks of the Kansas River, on the Atchison, Topeka and Santa Fé, the Chicago, Rock Island and Pacific, the Union Pacific and the Missouri Pacific, 67 miles west of Kansas City. The city is well laid out with broad streets crossing at right angles and beautifully shaded. Topeka was settled by people from the «Free State» in 1854; an anti-slave constitution was adopted here in 1856 known as the «Topeka Constitution» and the Topeka government was established by national authority. It was incorporated as a city in 1857 and selected as the State capital in 1861. The principal industries are the railroad shops of the Atchison, Topeka and Santa Fé Railway, printing plants, six flouring mills having a capacity of 5,000 barrels per day, creameries, packing-houses, foundries, machine shops, boiler works, preserving works, silo factories, engine works and planing mills. According to the United States census of manufactures of 1914 Topeka had 159 manufacturing establishments with a combined capital of $14,186,000, employing 5,721 persons, paying $3,691,000 in wages and manufacturing a product valued at $20,000,000. Topeka has 10 banks, three of which are national banks and three building and loan associations with assets of $9,000,000. Topeka is an important jobbing centre, there being four wholesale groceries, six wholesale commission houses, wholesale hardware, paper, drugs, etc. It is one of the chief railroad centres between the Missouri River and the Pacific Coast. The State capitol, a handsome stone edifice, is the most important building of the city. The State Memorial building, erected to the memory of the veterans of the Civil War at a cost of $550,000, is the most handsome structure in the city. The government building and the court house are also creditable buildings. Topeka has a municipally owned city building with auditorium annex with seating capacity for 5,000 people. Just west of the city, two miles, is the State Hospital for the Insane; the State Reform School is located just north of the city about three miles. The Colored Industrial Institute is a coeducational institution for colored boys and girls located just east of the city. Orphans Home — two Crittenden Homes, one each for the unfortunate white and colored girls, the Provident Association Building, Ingleside Home for Old Ladies, a Methodist Home for the Aged are among the most notable of its charitable institutions. The Santa Fé Railroad maintains its own private hospital and the public hospitals are Saint Francis, Christ's Hospital and Stormont Hospital. The city has a free public library, a well-organized public school system, including a high school established in 1874; an excellent manual training school is also maintained. It is the seat of Washburn College, a coeducational institution for men and women, and the College of the Sisters of Bethany and three business colleges. Topeka has the commission form of government, having a mayor and four commissioners; a well-equipped fire department and an excellent police department. The city owns its own electric light and water plant. The cost of city government as reported by the United States government reports for the year 1915 shows $20.71 per capita as spent in Topeka for the maintenance of city government. The physical valuation of Topeka is about $56,000,000. The area of the city is 16 square miles. Topeka has over two miles of ornamental lighting system, has 240 acres of city-owned parks and play grounds. Pop. 52,250.

TOPELIUS, tō-pä'lē-oos, **Zachris,** Finnish author: b. Kuddnäs, near Nykarleby, 14 Jan.

1818; d. Helsingfors, 13 March 1898. He was graduated at the University of Helsingfors in 1840, in 1841–60 edited the *Helsingfors Fidningar,* in which many of his earlier writings first were printed, and held at the university the chairs successively of Finnish history (1854–63), of the history of Finland and the northern regions (1863–76), and of general history (1876–78). After Runeberg (q.v.), he is the chief poet of Finland. His religious and patriotic lyrics are particularly valued. Among the collections of his verse are 'Flowers of the Heath' (1845–54); 'New Leaves' (1870). He wrote also several dramas, such as 'After Fifty Years' (1851), and works of fiction, including 'A Surgeon's Stories' (1853–67), a cycle based on Finnish and Swedish history from the time of Gustavus II Adolphus, to that of Gustavus III. There are German translations of several of his writings and an English version of the 'Surgeon's Stories' has appeared in the United States (1883–88).

TÖPFFER, Rudolph, Swiss novelist: b. Geneva, 1799; d. there, 1846. In 1832 he became teacher of æsthetics at the Academy of Geneva and in 1839 his novel 'Le presbytère' attracted general attention to him and ensured his position in the world of letters. He was a voluminous writer and won renown for his 'Voyages en zigzag' (1848) which were continued with illustrations by himself in 1853. Among his best productions are his seven little novels in pictures which were published together in Geneva, 1846–47. Consult Wolterstoff, Hermann, 'Essai sur la vie et lis œvres de Rodolphe Töpffer' (Magdeburg 1894).

TOPHET, or **TOPHETH,** a locality described in Scripture as in the valley of Hinnom, near Jerusalem, where high places were erected, and which was the chief seat of the worship of Moloch, with its fiery human sacrifices and abominations. The good King Josiah suppressed that form of idolatry, and made Tophet a receptacle for the refuse of Jerusalem. Afterward it became a burying-ground. It was shunned with horror by the Jews, and the word has come to be used by Christians as the synonym of a place of punishment after death. The origin of the word is doubtful. It is derived by some from Hebrew *toph,* a drum, in allusion to drums beaten to drown the cries of children burnt in the fire to Moloch, and this seems a probable interpretation. Another derivation is from an Aramæan word signifying to spit or vomit, in allusion to the disgust excited by the place. Consult 2 Kings xxiii, 10; Jer. vii, 31–32; Isa. xxx, 33.

TOPIC, the subject of a discourse, whether written or spoken; the matter treated of in conversation, argument, oration, literary composition, etc. *In rhetoric and logic* topic was restricted to the narrower sense of a common ground of argument, a general maxim or dictum from which other arguments may be started: one of the various general forms of argument employed in probable reasoning, as distinct from demonstrative reasoning. *In medicine* the word is used to denote any remedy locally applied; it is, however, more frequently used in the plural, topics, denoting the class of such remedies, than applied to any one specific.

TOPLADY, Augustus Montague, English theologian and hymn writer: b. Farnham, Surrey, 4 Nov. 1740; d. London, 11 Aug. 1778. He was educated at Westminster and Trinity College, Dublin, and in 1768 was presented to the vicarage of Broadhembury, Devonshire. Though a voluminous writer — and a strenuous defender of Calvinism against John Wesley — Toplady is now hardly known except as the author of the hymn 'Rock of Ages,' one of the finest expressions of evangelical faith and fervor to be found in all hymnology.

TOPOGRAPHICAL SURVEYING. See SURVEYING.

TOPOLOBAMPO BAY, Mexico, a small bay of the Gulf of California on the west coast of the state of Sinaloa. It is noted on account of the attempt made in 1886 by a number of Socialists of the United States to form a coöperative community on its shores. A company was chartered, in which all the colonists were stockholders, and which was to own all the land, and conduct all the business of the community. Everything was to be done as far as possible on the socialistic plan as described in Bellamy's 'Looking Backward.' Several hundred colonists joined in the experiment, and a city was surveyed and laid out on an elaborate plan. The experiment, however, was a failure, largely owing to aridity of the land and the absence of available streams for irrigation. The place was abandoned in 1891.

TOPOPHONE, an instrument for determining the direction from which any sound proceeds. It is valuable for use at sea, during fog, or in the night, to determine the direction of a sounding bell, fog-horn, whistle, etc. The topophone was invented by A. M. Mayer, and consists of a centrally pivoted horizontal bar having at each end resonators, with their openings facing the same way, each with a connecting sound tube for the ears of the observer. In use the bar is turned until a position is found in which the sound is loudest and equally distinct in each ear. The location of the sound is at a right angle to the bar in the direction to which the resonators face.

TORAH, or **THORAH.** See PENTATEUCH.

TORBANITE, a lustreless variety of cannel coal, especially rich in volatile matter formerly used in the manufacture of illuminating gas, paraffin and lubricating oils. It occurs at Torbane Hill, near Bathgate, Scotland, but the supply is exhausted. See BOGHEAD COAL.

TORBERNITE, an ore of uranium consisting of a hydrous phosphate of uranium and copper, $CuO.2UO_3.P_2O_5 8H_2O$, obtained in Utah and Black Hills of South Dakota.

TORBERT, tôr'bẽrt, **Alfred Thomas Archimedes,** American soldier: b. Georgetown, Del., 1 July 1833; d. at sea off the coast of Florida, 29 Sept. 1880. He was graduated at West Point in 1855, was engaged on frontier duty in Texas, Florida, New Mexico and Utah in 1855–60, and at the outbreak of the Civil War was assigned to the duty of mustering in volunteers. He was commissioned colonel in 1861, and led his regiment in the Peninsula campaign of 1862; was assigned to the command of a brigade in that year; and participated in the second battle of Bull Run and in the battles of

South Mountain and Antietam. He was promoted brigadier-general of volunteers in 1862; commanded a brigade at Gettysburg in 1863; for gallantry there was brevetted major in the regular army; in April 1864 was transferred to the cavalry service and placed in command of the 1st division of the Army of the Potomac. He commanded the cavalry in many subsequent engagements, including those at Hanovertown, Milford, Winchester and Waynesboro. In 1864 he was brevetted major-general of volunteers, attaining the same rank in 1865 in the regular army. In 1866 he was mustered out of the volunteer service and resigned his regular army commission. He was United States Minister to the Central American States 1869–71, was transferred as consul-general to Havana, Cuba, and in 1873–78 was consul-general in Paris. He was lost in the foundering of the *Vera Cruz* off the coast of Florida.

TORCELLO, tŏr-chĕl'lō, Italy, an island in the lagoon of Venice, six miles above the city. It is the see of a bishop and possesses an ancient Byzantine cathedral of Santa Maria of the 7th century, with mosaics of the 12th century, curious altar-benches, an antique crypt, octagonal baptistery from 1008 and a belfry; Santa Fosca is another handsome church with a fine interior (12th century). Pop. 130.

TORDENSKJOLD, Peter, Norwegian naval officer: b. Trondhjem, 1691; d. 1720. He endeared himself to the people by his exploits in the navy to which he was appointed a lieutenant in 1711, and in 1716 was given noble rank for his victories. When but 25 years of age he destroyed the Swedish fleet of 44 ships and compelled the raising of the siege of Fredrikshald by Charles XII. He was made vice-admiral (1719) for the destruction of the principal Swedish squadron.

TORGAU, tŏr'gow, Germany, a town in the province of Saxony, Prussia, on the Elbe, 32 miles northeast of Leipzig. Prior to 1889 it was a fortified town, and has considerable historical significance in connection with (1) the Alliance of Torgau, a confederacy formed in 1526 by Saxony, Hesse and other German states in which Protestantism united for the purpose of defense against aggression on the part of their antagonists; (2) the Articles of Torgau, a declaration by Luther and his supporters in 1530, which was the foundation of the Augsburg Confession; (3) the battle of Torgau, fought in the suburb of Luptitz, 3 Nov. 1760, when the Prussians under Frederick the Great defeated the Austrians under General von Daun; (4) the siege of Torgau by Tauentzien in 1814, the city holding out for three months and surrendering 10 Jan. 1814. The Renaissance Hartenfels Castle of the 15th century was a former electoral residence. In the town-hall is a museum of Saxon antiquities. There is here a modern fort for the protection of the railway system. The royal stud farm was long located in the vicinity. Pop. about 13,000.

TORMENTIL, an old provincial name for various species of *Potentilla* (q.v.), a plant supposed to yield relief from the torment of toothache.

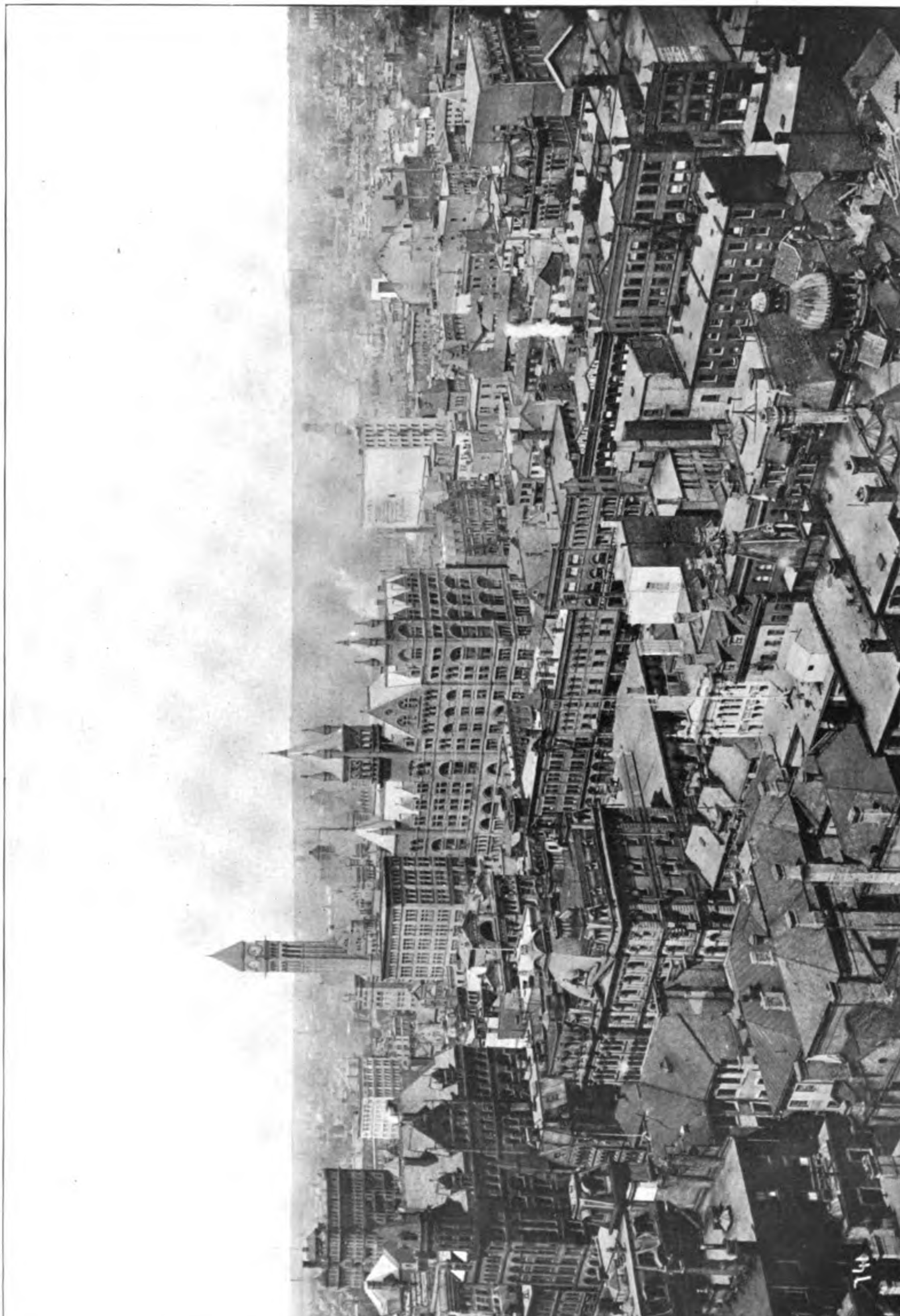
TORNADO, from the Spanish *tornada,* «a turning about,» the local name given in various tropical and subtropical regions, notably Senegal, to violent whirlwinds or cyclones, with the usual accompaniment of electrical disturbances and downpouring rain. See CYCLONE; METEOROLOGY; WIND.

TORNADO ALARM, an apparatus which automatically gives an alarm when there is a sudden change of atmospheric pressure, such as precedes a tornado. It is a form of barometer in which the main mercury tube has a cylindrical bulb at the top and is bent in the form of a siphon. Near the lower portion of its shorter member is a secondary tube, the connection being made by means of a short tube connecting with the main tube by a very small opening. The fluid in both the larger tubes will remain normally of equal or nearly equal height in ordinary changes of the weather, but in case of sudden atmospheric changes the small opening in the connection between the tubes restricts the movement in the secondary tube as compared with that in the main tube. Such variation in the movement of the mercury in the two tubes when sufficient to indicate an approaching storm, is made to give an alarm by means of floats in the tubes connected with wires in an electric circuit, there being on one wire a fork and on the other a tongue, by which contacts are made, to ring an alarm when the points meet. This alarm should sound some two minutes before the first blasts of the tornado. Ordinary storms have no effect at all on the apparatus.

TORNEA ELF, tŏr'nĕ-â ĕlf (sometimes written TOME), Sweden, a river at the north, which rises in Lake Tornea. Part of its course forms the boundary between Sweden and Finland, and then empties into the Gulf of Bothnia, after a course of 275 miles. The town of Tornea stands at its mouth and on the opposite side of the river the Swedish town of Haparanda.

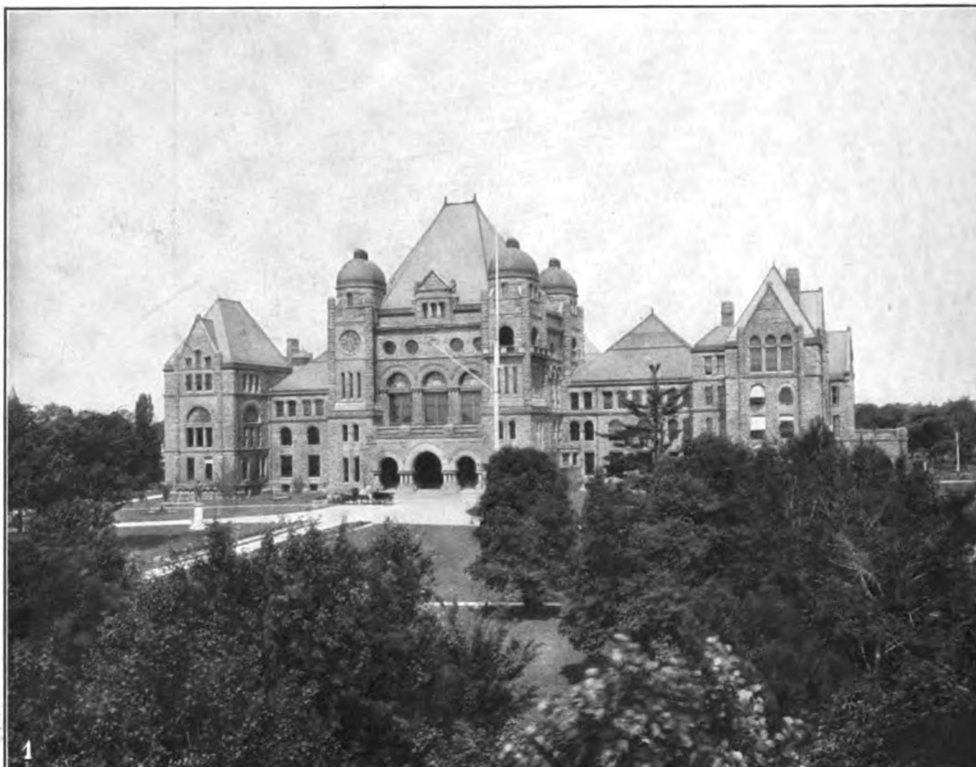
TORONTO, Canada, a city and lakeport, the capital of the province of Ontario, situated on the circular Toronto Bay between the mouths of the Don and Humber rivers, on the northwest coast of Lake Ontario, 313 miles west-southwest of Montreal and 60 miles in a direct line northwest of Buffalo, United States. It is the seat of the provincial government, of the higher law courts, of an important university and of the Department of Education of the province; it is also the cathedral city of a Roman Catholic and of an Anglican diocese. In commercial importance it is the second city in the Dominion, and, after Montreal, the chief railway centre. The Grand Trunk, the Canadian Pacific, and many branch lines connect it with the principal cities of Canada and of the northern United States, and it is the headquarters of the Canadian Northern and the Temiskaming and Northern Ontario railways. The fine harbor, five miles long and one and a half wide, is formed by a long, low, sandy island, protected by imposing breakwaters; this island is, in summer, a favorite bathing and boating resort. A great scheme of development, which includes the deepening and extension of the harbor, land reclamation, boulevard construction and the creation of industrial sites is in progress. The city rises gradually from the water's edge to a height of 220 feet; it extends from east to west for about 10 miles along the lake shore and from north to south from three

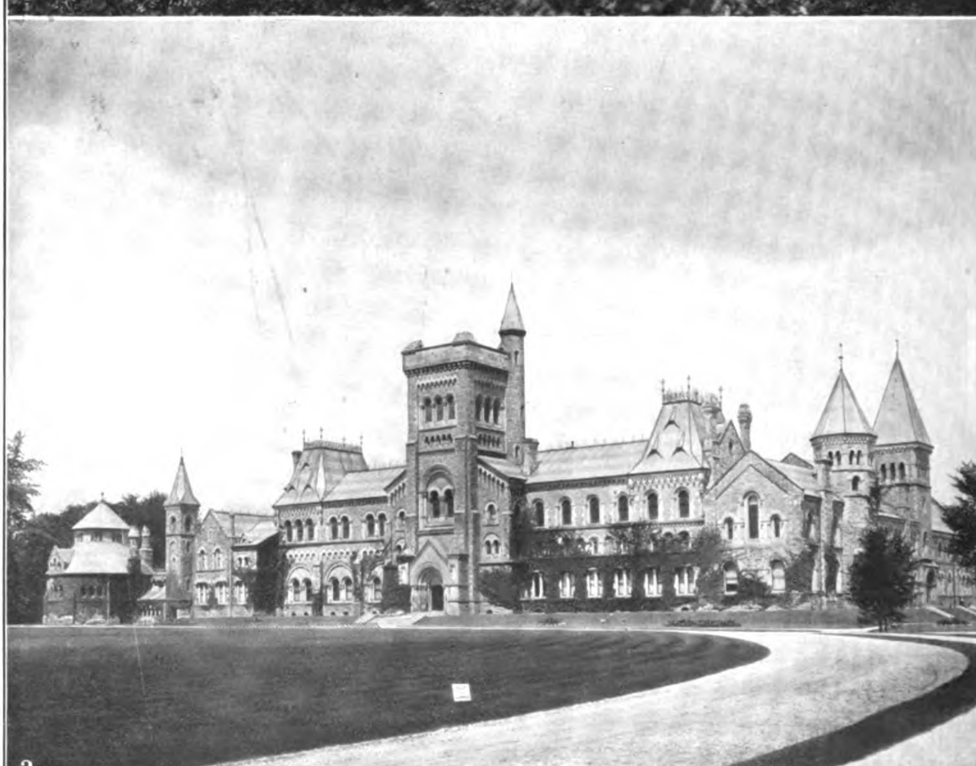
TORONTO, CANADA



Topley, Photo

View of the Centre of the City





1 Ontario Parliament Buildings

2 The University of Toronto

to seven miles, and covers an area of about 32 square miles, with streets crossing each other at right angles. An electric street railway system has about 144 miles of tracks. The architecture, especially of the numerous public buildings, is tasteful and imposing, and there are many fine shops and residences. Brick of a pleasing light color, or red, is the chief building material. Of the public buildings, the most striking group is that connected with the University of Toronto. The main building or University College, a fine Norman structure in gray stone, with a massive tower and richly sculptured doorway, was rebuilt after partial destruction by fire in 1890; the Library, the new Medical Building, the Biological Department, the School of Practical Science, with its handsome new engineering building in the Renaissance style, and a number of other large structures, unite with this to make up an imposing group, not wholly harmonious, but in a spacious setting of park land. Adjacent are the "Neo-Greek" Parliament buildings, containing the government offices, and a handsome and well-decorated legislative hall. The magnificent city hall and courthouse is, next to the university, the most striking of Toronto's buildings. Others worthy of mention are Osgoode Hall, the seat of the provincial law courts; the Normal School buildings, offices of the Department of Education; Central Technical School; Trinity College, in connection with the Church of England, an ornate building, in the late Gothic style; the custom house, the post office, the exhibition buildings, where an important annual exhibition is held, and the lunatic asylum, in about 40 acres of ground. A new Union railway station to cost $5,000,000 is in course of construction. The churches most worthy of notice are the Roman Catholic and Anglican cathedrals, both in the pointed style; the latter is an excellent specimen of Early English. There are numerous theatres and many public halls, the chief being the Massey Music Hall, which will hold 4,000 or 5,000 people. Toronto has 1,329 acres of park, the chief being Queen's Park, adjoining the university, and the extensive High Park, at the west of the city. It is a great educational centre. The university (see following article) is one of the best equipped in America. Educational institutions connected with it are Trinity College (already mentioned); Victoria College (Methodist, arts and divinity); Knox College (Presbyterian, theological); Wycliffe College (Anglican theological); Saint Michael's College (Roman Catholic), and colleges for instruction in music, dentistry, pharmacy and veterinary science. Its agricultural college is situated not at Toronto but at Guelph, Ontario. McMaster University is an independent Baptist institution, teaching arts and divinity. Upper Canada College, in spacious grounds, is a residential school for boys, as is also Saint Andrew's College, the site of which was acquired in 1917 for a military hospital. Havergal College is a similar type of school for girls, and besides it are Bishop Strachan's School, Saint Margaret's College, etc. The Toronto Conservatory of Music has a very large number of pupils. The Observatory, at which the weather reports for the Dominion are made up, is in the university grounds. Toronto has suffered from destructive conflagrations, notably in 1849, in 1890 and in April 1904, when more than 100 buildings in the wholesale business section were burned down, some 5,000 persons were thrown out of work, and about $11,000,000 worth of property was destroyed. The industries of Toronto include a great agricultural implement factory, iron foundries, shipbuilding, rolling stock, distilling and brewing, pork-packing, the manufacture of soap, tanning, aeroplanes, etc. The city possesses a well-equipped system of public libraries, with a fine reference library centrally located, in which the John Ross Robertson historical and ornithological collections are housed. Shipping on the lakes is laid up in winter, but during the navigable season several lines of steamers connect with the principal ports on the Great Lakes and the Saint Lawrence. The lake commerce in lumber, grain, coal, cattle and fruit is large. Toronto's bank clearings in 1917 were $3,004,785,565; customs revenue, $35,732,400. The city has over 1,700 manufacturing establishments, employing 80,000 hands.

The name Toronto is derived from the Huron word, signifying "place of meeting." In 1749, when the French were establishing a chain of forts or posts through all the West and down the Mississippi Valley, Fort Rouillé was founded, on a site even then often called Fort Toronto. In 1756 this fort, on the west side of the present city, was destroyed to prevent its falling into the hands of the English. In 1793 Governor Simcoe finding Niagara or Newark, which lay almost under the guns of an American fort, too close to the frontier for the seat of government, removed the capital to the other side of Lake Ontario and established his headquarters in a tent, on a site in the eastern part of the present city. In 1813 Toronto, called York by Governor Simcoe, was captured and partially burned and looted, twice in the same year, by the American army and navy. In the first capture the American General Pike, the discoverer of Pike's Peak, together with many soldiers, was killed by an explosion. In 1834 Toronto was incorporated as a city with its present name. In 1837 it was the chief scene of a brief and ineffectual rebellion under William Lyon Mackenzie (q.v.). At that time and often since Toronto has shown itself to be fervently British in sentiment. Its later history has been purely civic, without other interest than that attaching to prosperous growth. A pleasant society and an attractive situation make it a favorite place of residence. Population has increased rapidly. In 1793, when Governor Simcoe landed, there were only a few families. In 1834 the population was less than 10,000. In 1861 it had increased to 44,821, in 1871 to 56,092 and in 1881 to 86,415. In 1891, including some annexed suburbs it amounted to 181,220, and in 1911 to 376,240. Police census (1917), 535,271.

Consult Scadding, 'Toronto of Old'; Scadding and Dent, 'Toronto, Past and Present'; Adam, 'Toronto, Old and New'; and 'The Toronto Annual.'

George M. Wrong,
Professor of History, University of Toronto.

TORONTO, Ohio, village in Jefferson County, on the Ohio River, and on the Pennsylvania Railroad, 10 miles above Steubenville, the county-seat. It is in a region in which there are extensive beds of clay and large stone quarries. It is near the natural-gas fields of West Virginia. The chief manufacturing establishments are potteries, brick and tile works. The shipments are chiefly pottery, sewer pipe, terra-cotta and fire-brick. Pop. 4,271.

TORONTO, University of, situated at Toronto, Canada, the head of the educational system of the province of Ontario. The first step toward the establishment of the university was taken in 1797 when the council and assembly of Upper Canada petitioned the king for an appropriation of Crown lands for the purposes of education, and the establishing of a university. The appropriation was made, but nothing further was done toward the founding of the university until 1827, when it was chartered under the name of the University of King's College; the organization of the university was further delayed, largely owing to objections to the sectarian character of its charter, which was amended in 1837; and it was not till 1843 that it was opened to students. In 1849 the name was changed to the University of Toronto; in 1853 the university was further transformed by the organization of two corporations, known as the University of Toronto and the University College; to the latter was assigned the teaching in arts and the entire control of its students. In 1887 a further organization of the whole university took place. Under what is known as the «Federation Act» the university became a teaching body once more, with faculties of arts, medicine, applied science and engineering, to which have been added since, faculties of education, forestry, household science and music. In the faculty of arts the subjects were divided as between the University of Toronto and University College, which may be termed the State Arts College, the complement of the faculty of arts of the university. In this reorganization of the faculty of arts there are now Victoria College, representing the Methodist Church of Canada; Trinity College, representing the Church of England; Saint Michael's College, representing the Roman Catholic Church — so that there are four arts colleges giving instruction in the same arts subjects, but sending their students to the university for instruction in other subjects, among which are mathematics, sciences, philosophy, political science, history.

The institutions which have close relations with the university are either federated or affiliated. Among the federated institutions, outside the arts colleges, are Knox College and Wycliffe College, while among the affiliated colleges are the Ontario Agricultural College, the Royal College of Dental Surgeons, the Ontario College of Pharmacy and the Ontario Veterinary College. These federated and affiliated colleges are represented on the senate of the university, which has charge of the educational policy. Each faculty has its own council and has charge of the discipline and control of its students, while the caput is made up of the chief executive officers of the university, together with the heads of the federated colleges.

The university receives a very substantial grant annually from the government of the province of Ontario and is affiliated with the leading universities of Great Britain and Ireland, as well as with the General Medical Council of Great Britain.

The degrees offered by the university include arts, medicine, applied science and engineering, pedagogy, forestry and music, under the regular faculties, while through the affiliated institutions degrees are given in law, dentistry, agriculture, pharmacy, with diplomas in public health and physical training. Extension and summer session work are carried on in the faculty of arts. The university is coeducational and had during the session 1918–19 an attendance of approximately 3,000, which is likely to develop to a greater attendance than in pre-war days, when the enrolment exceeded 4,000.

The important buildings are the main building, convocation hall, the library, household science, the various laboratories and within Toronto the buildings of Victoria College, Trinity College and Saint Michael's College.

Provision is made for the undergraduate activities of the men in Hart House, the gift of the Massey Estate. There are residences for men students of the university and for both men and women in University College, Victoria, Trinity and Saint Michael's colleges.

TORPEDO, a genus of rays of the family *Torpedinidæ,* most remarkable for their electric organs, which lie on each side of the head. (See ELECTRIC FISHES). The electric shock is powerful enough to kill small animals, and specimens two or three feet long can by a single discharge disable a full-grown man. The family, which includes about seven genera and 15 species, is widely distributed over the Atlantic and Indian oceans; *T. marmorata* and two others are common in the Mediterranean, and *T. hebetans* reaches the south coasts of Britain. The American form most often seen is *T. occidentalis,* which may reach a weight of 200 pounds; it is uncommon, but occasionally seen along the coast from Cape Cod to Cuba.

TORPEDO, Automobile. See AUTOMOBILE TORPEDO.

TORPEDO-BOAT DESTROYERS. See ANTI-TORPEDO BOATS.

TORPEDO BOATS. The torpedo boat first made its appearance as an adjunct to the fleet in 1886. At that time its displacement was less than 100 tons, and its speed about 20 knots an hour. From that time on it gradually increased in size and speed until in 1896 its displacement was about 125 tons and its speed about 23 knots an hour. The next evolution was the destroyer. This new type of vessel became necessary, for the dangerous character of the torpedo boat was fully recognized, armed as it was with an inaccurate weapon. During the revolution in Chile in the early nineties a battleship was destroyed by a torpedo fired at night from a large torpedo boat, and during the Japanese-Chinese War in the middle nineties torpedo boats were freely used by the Japanese.

As the years went by the range and accuracy of the torpedo rapidly improved and the torpedo boat increased its size to make it more habitable and seaworthy. Its tonnage soon rose to 400 tons and then merged into the destroyer. As the size of the torpedo boat still increased, destroyer tonnage was compelled to keep pace, the final or present destroyer displacement of about 1,100 tons (with a speed of about 32 knots per hour) having been reached and determined by most nations from a consideration of the strategical and tactical duty of the fleet with which it serves. The offensive weapon of the destroyer was originally the gun, but after the torpedo boat disappeared the torpedo became the important weapon and the guns were retained for defense only. The pivotal characteristics of the destrover were high speed, seaworthiness, moderate radius of action and plurality of torpedo tubes and torpedoes. To enhance these characteristics increased size was necessary and this lessened the chance of being able to surprise an enemy on the alert, and surprise was a corollary in its usefulness. These considerations tended to limit the size and when sufficient tonnage for necessary offensive work was gained, no further increase was thought justified. The present tendency is to increase the destroyer's gunpower for offensive purposes against the submarine and this brings the destroyer back to the original conception of the use of that type. Further development will undoubtedly be toward high speed, moderate size, long-range torpedoes, a plurality of small guns and large radius of action. The destroyer, supported by large cruisers, makes an excellent offensive force, especially when armed with long-range torpedoes. Making contact in the daytime with an enemy's fleet, destroyers can, at night, readily slip through the screen and attack the enemy while in its night formation.

A well co-ordinated destroyer force becomes a most important asset to a fleet when about to go into battle. A well-timed feint upon the battle line of the enemy may give to its own battle line a verv important advantage of position. By the intelligent use ot a *smoke screen,* made by emitting large volumes of oil smoke from destroyers' smoke stacks, a battle line in confusion can be rescued from destruction and permitted to reform or to escape. In the battle of Jutland the German fleet was concealed in a smoke screen formed by German destroyers at the time when the main British fleet was about to bring a superior force against it. When the smoke cleared it was observed that the German fleet had extricated itself from danger.

While the first duty of the destroyers was to run down attacking torpedo boats and sink them with the fire of their small rapid-fire guns, it was also armed with torpedo tubes in order that it might be used as an attacking torpedo vessel and to defend the battleships at night. The smaller type of torpedo vessel — the torpedo boat — was classed as a weapon of defense, employed to guard the home coast from raids by the enemy's warships, while the larger was regarded as an offensive weapon, used to destroy the smaller type and allow capital ships to perform, without danger, their duties of blockade and various war measures. See SUBMARINES.

EDWARD S. FARROW,
Consulting Military and Civil Engineer.

TORPEDO DRAG, a device for clearing harbors, river-channels, etc., from floating torpedoes and submarine mines. It consists of a long cable, bearing grappling hooks set at frequent intervals. The ends of the cables are made fast in boats, one on either side of the channel, and as the vessels proceed up and down the channel, abreast, the hooks on the rope between them catch the torpedoes. Sometimes a drag is thrown ahead of a vessel by a small mortar and is drawn in by a windlass; this is to clear the channel through which the vessel must pass.

TORPEDOES. Torpedoes or explosives moving through the water to the object attacked, as distinguished from the mine or stationary explosive, first took the form of what was in reality a towed mine. The Harvey, Menzing and the various French towing torpedoes were weapons of this kind. The torpedo was towed astern of a launch with a rig that permitted a rudder on the torpedo being controlled from the towing boat. The torpedo could be guided to a position on the quarter, while a second torpedo was towed astern. By means of a dipping or detaching apparatus, when the whiskers of the torpedo touched the target, the torpedo would become completely submerged before the explosion took place. Torpedo warfare received great impetus during the Civil War, various types being developed by both the Confederates and the Federals. Dragging for torpedoes and the use of torpedo nets dropped over the sides of vessels were then first practised, but there appears to have been no use of submarine boats until more recently. During this war the spar or outrigger torpedo came into active use and on more than one occasion during that period and later proved its worth. This weapon consisted of a torpedo carried at the end of a spar or pole which projected from a launch. It was so arranged that just before the target was struck, the torpedo could be plunged below the surface to obtain the holding or plugging effect of the water for the explosion. The explosive usually consisted of about 33 pounds of guncotton which could be fired upon contact, or at will, by employing a firing battery. To carry and drive home the spar torpedo a fast seaworthy launch or small torpedo-boat was employed.

In its early stages of development, battle ranges seemed logically to keep the torpedo in the background, except at night, when the speedy torpedo-boat counted upon getting near enough to launch its weapons with a more reasonable promise of making a hit. The naval constructor, accepting the torpedo at its potential value as seen by the majority of the fighting officers simply limited his efforts to fabricating the under-body of his fighting craft so that the damaging effects of a chance blow from a torpedo should be confined to a restricted area. Hence the inner and the outer bottoms, and the water-tight, cellular divisioning of the intervening space. As a matter of fact, the naval constructor's work stood up under torpedo attack and performed its function remarkably well. It is a matter of record, that the general run of torpedoes fired during the Russo-Japanese War did far less damage than was expected of them, and a goodly number of vessels so struck were not sunk as was counted upon, but were able to get into port and be repaired. There were ships lost to both belligerents by subaqueous attack, but the most conspicuous of these disasters were due to the violent blows of passive mines. Where the active torpedo had failed in its mission the anchored floating mine filled the offensive gap. These mines carried larger explosive charges than the torpedoes then in service, and proved two things: First, that the naval constructor had planned well; and, second, that the automobile torpedo must needs be made a more powerful weapon if it were to fill the office intended for it. In the Russian fleet at Port Arthur were several vessels that had been built by the French for the Russian government. In addition to the usual compartmenting of the inter-bottom space, the French designers had reinforced the region most likely to be attacked by torpedoes by means of a caisson built of plating nearly two inches thick. The object of this caisson — assuming that the explosion of the torpedo should be sufficient to rend or rupture the plating of the inner and outer bottoms — was to provide more space in which the guncotton gases could expand and dissipate the most dangerous percentage of their remaining force. The ingenious theory of this style of construction was proved to be all that its originators claimed for it. The Russian ships so built were several times hit by Japanese mines, and while grievously wounded over wide areas of their under-bodies, yet the caissons remained substantially intact and the vessels were able to return to harbor.

The automobile torpedo first came into use in the early seventies. It was the outcome of a series of experiments commenced in 1864 by Robert Whitehead, then superintendent of iron works at Fiume, Austria. This torpedo, known as the Whitehead or fish torpedo, claimed the following capabilities: (1) It could be adjusted to run at any depth from 5 to 15 feet when fired from either a submerged or surface tube, or from a surface detaching apparatus; (2) upon firing, it would make a straight run, provided a proper allowance was made for the deflection due to transverse currents; (3) it could be adjusted to stop at any distance up to its extreme range and after stopping to sink or float; (4) it could make a run of 1,000 yards at a speed of 15 or 16 knots, while 300 yards could be covered at a speed of 19 to 20 knots; (5) it could carry a warhead holding a charge of 33 pounds of guncotton, to explode upon contact. This torpedo was propelled by a three-cylinder Brotherhood engine weighing 35 pounds, driving two propellers and developing 40 horse power. Eventually the Whitehead torpedo came to be used in the United States service, and later the Bliss-Leavitt torpedo was adopted. As heavier armor was added against torpedo attack a large gap developed which the Whitehead torpedo and its various kindred rivals could not fill, and here it was that the genius of an American naval officer, Commander Cleland Davis, placed the torpedo upon a new and more formidable footing. He abandoned the guncotton warhead, which was the accepted instrument of destruction since the inception of the Whitehead, and substituted a gun in its stead. If one will study carefully the photographs of either bursting submerged mines or exploding automobile torpedoes, the most impressive visual sign of the violence exerted will be found in the great volumes of water blown upward. The water has yielded more than the steel structure attacked, and the major part of the energy designed to wreck has spent itself uselessly in blowing hundreds of tons of water into the air. Commander Davis sought so to concentrate the powers of assault in his torpedo that but little of its force should be dissipated in disturbing the surrounding water while the bulk of the energy of his weapon should remain unimpaired and centred in piercing the enemy's defenses and penetrating to the very vitals of the object of attack. He did not discount in the slightest the truly remarkable developments which had taken place in the other departments of the automobile torpedo. Increased range, higher speed and more precise functioning all helped him toward his objective; but it is his invention which made this underwater projectile a graver menace to the largest of fighting craft. This torpedo carries an eight-inch gun capable of expelling an eight-inch projectile with a muzzle velocity of 1,000 feet per second, which is quite enough to carry the projectile through a single plate of Krupp armor, something like four or five inches thick, where virtually in contact with the muzzle of the gun — as would be the case with this torpedo. Ships are not protected under water with plating of these dimensions, and it would be a much easier task for the projectile to pass successively through a number of thinner plates even if their combined thickness were more than the limit set. The projectile fired from this torpedo carries a bursting charge of high explosive of between 35 and 40 pounds. This charge is detonated by a delayed action fuse, which is designed to meet the maximum requirements imposed by the best protected dreadnaughts built. When this weapon is launched upon its sinister errand the little propeller at the upper side of the torpedo's nose revolves and releases the tripping rod, so that the torpedo can be discharged upon contact with its target. When the rod hits the obstruction it is driven backward and engages the trigger which first compresses a spring attached to the firing pin and then releases it so that the pin can strike the gun primer, thus setting off the propelling charge of powder which drives the shell out of the gun. As soon as the projectile hits the outside plating of a ship's bottom the fuse in the base of the shell begins to function, being set to explode the charge in the shell so many hundredths of a second after impact.

The modern submarine torpedo varies in size according to the service for which it is intended and ranges from 14 inches in diameter and 15 feet in length to 21 inches in diameter and 21 feet in length, weighing from 1,000 to 2,600 pounds, the smaller type being used to sink unprotected freight and passenger ships at short range. It is capable of a speed of more than 30 miles per hour and when traveling at normal speed possesses the great momentum of about 65,000 foot second pounds. Generally speaking, the torpedo consists of the following parts: (1) The warhead, which contains the high explosive charge, fired by an exploder upon striking the target, the charge ranging from 200 to 500 pounds, depending upon the type of torpedo; (2) The air flask, a specially constructed shell of steel, very strongly built to withstand a test pressure of 5,000 pounds to the square inch. This flask carries air at an initial pressure of 2,250 pounds per square inch, the air being used to operate all the mechanism of the torpedo in addition to the motive power; (3) The depth control mechanism, which permits the torpedo to be run at any desired depth under water, and which consists principally of a pendulum and a hydrostatic piston actuating horizontal rudders; (4) The gyroscopic steering gear. The gyrostatic compass through the vertical rudders maintains the torpedo on a course parallel to that in which the torpedo began its run; (5) The engines. The air at the high pressure of 2,250 pounds per square inch first passes through a reducing valve which decreases its pressure to that required for use by the engine. This air is then heated by an alcohol flame, which also acts to produce steam of the water in the combustion flask, the air and steam mixing and passing to the engine. The engines are generally reciprocating, but in the Bliss-Leavitt and some other torpedoes are turbines driving two propellers.

Torpedoes are projected by means of special forms of tubes or guns. The tube is usually built into the hull of the submarine, in which case it is aimed by manœuvring the boat. In the case of destroyers and battleships, the torpedo may be projected from submerged tubes or from deck tubes. In general, torpedoes are projected from submerged tubes by compressed air and from deck tubes by a small charge of gunpowder. Submerged tubes on battleships, however, may be designed to use either powder or compressed air. When the torpedo is fired from a submerged tube the compressed air or the gas from the powder follows the torpedo out of the tube with a rush and causes an eruption on the surface of the sea, which is visible for a considerable distance. As a result of the warning given by this eruption, vessels have sometimes been able to escape the torpedoes by a quick manœuvre. The modern torpedo is self-propelled, being driven through the water by its own compressed air motor, the air being supplied from a strongly-built reservoir within the body of the torpedo itself. Torpedoes directly operated by internal combustion engines as motive power are not trustworthy. The range of a torpedo is approximately a mile, those designed for use on battleships and destroyers being longer ranged than those for use on submarines. The great difficulty in getting proper direction and sufficient motive power to give the required speed for a long duration of time renders the long range torpedo impracticable. The latest German torpedo had a range of about 2,000 yards, as the compressed air storage reservoir was reduced in size in order to increase the charge of high explosive in the warhead. The charge was from 300 to 400 pounds. The depth at which a torpedo travels may be regulated to hit the most vital part of the vessel, and that is usually about 10 feet below the surface. In case of torpedo attack against an armored ship the torpedo, to be dangerous, should strike beneath the armor belt, which usually extends about 10 feet below the water line. Torpedoes are usually provided with means to cut, more or less effectively, through nets placed in their paths. The detonation of the torpedo is accomplished through a mechanism placed within its warhead; and if the torpedo is checked in its forward motion the firing mechanism instantly ignites the heavy charge of explosive contained within the warhead. It is not necessary to strike a firing pin on the end of a torpedo to detonate the charge. Many suggestions have been submitted for a torpedo to be electrically propelled from a ship by means of a flexible cable connecting it with the ship. This was the first type of torpedo built, but was discarded for the present dirigible type, as the weight of cable, difficulties in insulation, etc., render it of little practical value. The effectiveness of the Hammond radio-controlled torpedo is promising. The Board of Ordnance and Fortifications recommended favorably to the Secretary of War as to the merits of this invention, and the Secretary recommended to Congress that this new type of weapon be installed in a few of the more important coast defenses.

When firing a torpedo at a moving target there are several important factors which the torpedoist must consider. These are the speed of the target, the course of the target and the speed of the torpedo itself, all of which factors must be known within limits in order to make effective hits. The various nations have their preference for torpedoes. The British use the Whitehead; the Germans, Schwartzkopf; the French, Whitehead and Schneider; the Japanese and Italians, the Whitehead. In the United States the Whitehead and Bliss-Leavitt torpedoes are in general use. See NAVAL MINES; SUBMARINE MINES; SUBMARINES.

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EDWARD S. FARROW,
Consulting Military and Civil Engineer.

TORQUAY, tôr-kē', England, a fashionable watering place in Devonshire, situated on the south coast, 26 miles northeast of Plymouth, named from the Tor Abbey nearby, which was founded in 1196. It is built on a series of terraces rising from the beach, and is a much frequented bathing and winter resort. It consists largely of villas and gardens, and has a fine promenade, public parks, libraries, a museum, electric light and an excellent water supply and drainage system. There are manufactures of terra-cotta ware, and trade in coal and marble. The name also applies to the borough and the Parliamentary division in which it lies. Pop. of the borough about 39,000.

TORQUE, an ornament of twisted gold or other metal, worn as a collar or a necklace by the ancient peoples of Asia and northern Europe. It consisted of a circle of stiff gold, twisted except at the ends, which remained straight or which in some cases were looped back, so as to overlap. Such collars were considered a characteristic ornament of the ancient Gauls and are said to have been so abundant that about 223 B.C., Flaminius Nepos erected to Jupiter a golden trophy made from torques of conquered Gauls. The Torquati, a family of Manlian gens, attribute their name to their ancestor T. Manlius, who having slain a giant Gaul in single combat lifted from the neck of the dead body an enormous gold torque, which he ever afterward wore upon his own.

TORQUEMADA, Juan de, hoo-än' dā tōr-kā-mä'thä (Latinized form TURRECREMATA), Spanish theologian and cardinal: b. Valladolid, 1388; d. Rome, 26 Sept. 1468. He entered the Dominican order in 1403, and was graduated at the University of Paris in 1424. After serving as prior at Valladolid and Toledo, he was appointed by Eugenius IV master of the sacred palace in 1431. In 1439 he became a cardinal-priest, later exchanged his title for the cardinal-bishopric of Albano, and still later (1464) for that of Sabina. He gave liberally of labor and money to charities and church-building, and won fame as a theological writer and controversialist. He was an influential member of the councils of Constance, Basel and Florence, at the last-named of which drew up the proposals for union between the Greek and Latin churches. Among his works may be mentioned 'Meditationes' (1467); 'Quæstiones Spiritualis Convivii Delicias præferentes super Evangeliis' (1477); and 'Commentarii in Decretum Gratiani' (1519). Consult Lederer, 'Der spanische Cardinal Johannes von Torquemada' (1879).

TORQUEMADA, Tomás de, Spanish monk, first Grand Inquisitor of Spain: b. Valladolid, 1420; d. Avila, 16 Sept. 1498. He entered the Dominican order, was for 22 years prior of the monastery at Segovia, and in October 1483 was made by Sixtus IV inquisitor-general for Castile and Leon. The Inquisition (q.v.) had been established in 1480 at Seville, but Torquemada was the first to give it its organization. He founded four tribunals at Seville, Cordova, Jaen and Villa Real. During his 18 years of office he burned 10,220 persons and condemned 6,860 to be burned in effigy. By these methods the Inquisition acquired vast sums of money. Torquemada was justly hated, and never went about without a body guard. His later activities were directed against the Jews and about 1,000,000 of them fled the country to escape his persecution. He was one of the most bloodthirsty fanatics of history. Consult standard works on the history of Spain and of the Inquisition; also Molènes, 'Document Inéditis. Torquemada et l'Inquisition' (1897).

TORRE DEL GRECO, tŏr'rĕ dĕl grä'kō, Italy, on the Bay of Naples, seven miles southeast of Naples at the foot of Vesuvius. The town has been demolished by earthquake at various epochs, and in 1857 and 1906 a similar disaster greatly changed and damaged the locality. It is much frequented by foreigners as well as Italians on account of its sea-bathing. There are important coral and other fisheries, besides shipyards, manufactories of rope, coral goods and lava ware. Pop. of commune about 36,000.

TORRENCE, Frederic Ridgely, American poet: b. Xenia, Ohio, 27 Nov. 1875. He was educated at Miami, Ohio and Princeton universities, was librarian in the Astor Library 1897–1901, and since 1901 at the Lenox Library, New York. He has published 'The House of a Hundred Lights' (1900); 'El Dorado: a Tragedy' (1903); 'Abelard and Heloise' (poetic drama, 1907).

TORRENS, William Erskine, American promoter: b. New York, 15 July 1870; d. 20 June 1914. After making a study in the mills of New England and Philadelphia of manufacturing methods and finance, he became in 1896 foreign commissioner for the National Association of Manufacturers of the United States, and was thus engaged until 1899. During this time he secured concessions from Brazil, Venezuela, Argentina, Cape Colony, China and Japan for establishing sample warehouses for the exhibition of American manufactured goods. He has written 'Commercial Traveling in South America' (1897); 'Commercial Traveling in South Africa' (1898); 'Commercial Traveling in the East' (1899).

TORRENS, Lake, South Australia, a large shallow salt lake, the central one of a group in the central southern section, 125 miles long and 25 miles wide, about 50 miles north of Spencer's Gulf. In the dry season it is reduced to a salt marsh.

TORRENS SYSTEM, a system of title-registration devised by Sir Robert Torrens, and first successfully used in Australia. Its object is to make the transfer of landed property as simple and as safe as that of any other property and to do away with the necessity of repeated title examinations. The system is operated through a bureau of registration, in charge of a registrar, and becomes effective on the first transfer of any property after the establishment of the system, all land transactions being registered in this office. A title may be registered as absolute or as possessory. Before registry the title is fully investigated by the registrar, who receives from the owner all the documentary evidences of title, descriptions of boundaries, etc. When the registrar is satisfied that the title is perfect, he files away all these old papers and issues to the holder a certificate of ownership, a duplicate of which is filed in the registrar's office. Such certificates bear on their faces notice of all encumbrances on the property. If the estate is vested in fee simple the title is known as «absolute» and the certificate is stated to be an absolute certificate. Should it appear that an absolute title to any land can be held only for a limited period or subject to reversions, then the registrar will except from the effect of registration any estate, right or interest arising before the specified date or under the conditions named, all of which will be entered in the register and noted on the certificate, which is stated to be a «qualified» certificate. In the case of a «possessory» title the applicant is registered as becoming owner on giving such evidence of title as may be prescribed, and the registration of any person as first owner with a possessory title only will not interfere with the enforcement of any estate, right or interest adverse to the title that may then exist or which may arise a later date. And this fact is noted on the «possessory» certificate issued to the owner. This examination and registration of title does not have to be repeated after a certificate has once been issued, the transfer of the certificate with accompanying entry of that fact in the registrar's office completes the transaction. By this method the transfer of a land title certificate becomes as simple and as inexpensive as the transfer of a certificate of stock or of a bank share, and the holder of the title is absolutely free from the usual danger of land title transfers, such as flaws in the title, the neglect of obscure future conditions, etc. Should any person suffer loss through misdescription, omission or any other error in the certificate issued by the registrar, he is indemnified from an insurance fund created for that purpose. This fund is provided by the imposition of a tax of one-fourth of 1 per cent on the value of the land at the time of the first certificate of title being granted, in addition to the registration fees. The registrar is the judge in all cases as to the liability of the fund to such compensation. The fees for registration under the Torrens system are very small, usually being $24 in case of the first registration, and three dollars upon the issue of every subsequent certificate. The system has been vigorously opposed by title guaranty companies and by members of the legal profession who see in it an end to a fruitful source of fees since under it there is furnished State title insurance instead of private title insurance, with nominal cost for conveyances.

The Torrens system is in use in South Australia (1858), British Honduras (1858), Vancouver (1860), consolidated with British Columbia (1866), Queensland (1861), Tasmania (1862), New South Wales (1862), Victoria (1862), England (1862, 1875, 1897), Ireland (1865, 1891), New Zealand (1870), British Columbia (1871), Western Australia (1874), Wales (1875, 1897), Fiji (1876), British Guiana (1880), Ontario (1885), Manitoba (1885), Canadian Northwest Territories (1886), Leeward Islands (1886), Jamaica (1888), British New Guinea (1889), Cyprus (1890), Illinois (1895), Ohio (1896), California (1897), Massachusetts (1898), Minnesota (1901), Oregon (1901), Philippine Islands (1902), Colorado (1903), Hawaii (1903), Nova Scotia (1904), Alberta (1906), Saskatchewan (1906), Washington (1907), New York (1908), North Carolina (1913), Mississippi (1914). The Massachusetts law is the best and the most successful in the United States; the New York law has been in great part a failure, due to defects in the act, of which the opponents of the system have taken advantage. Since the original Torrens Act gave a judicial and discretionary power to the registrar not in conformity with the spirit of American institutions, this portion of the law has been slightly changed in order to adapt it to the requirements of this country. Consult Niblack, William, 'Analysis of the Torrens System' (Chicago 1912); Cameron, A. G., 'The Torrens System' (Boston 1915); id., 'The Torrens System, Its Cost and Complexity; a legal and Practical Treatise' (Chicago 1903); Torrens, Sir Robert, 'Essay on the Transfer of Land by Registration' (London); Beers, W. F., 'The Torrens System of Realty Titles' (New York 1907); Kennedy, J. P., 'List of References on the Torrens System' (Virgina State Library, Richmond, Va., 1906).

TORRENTS OF SPRING ('Véshniya Vódui'), by Iván Sergéyevitch Turgénief, is the tragi-comedy of a man of weak will who succumbs to a passionate impulse, yields to the seductions of the typical "vampire" woman and throws away the happiness of his whole life. "Weak men," says the author, "never bring things to an end; they always wait for the end to come." The title is symbolical and not quite adequate, the comparison being introduced in the wrong place.

Sánin, a young nobleman, is in his 22d year, very good-looking, with handsome graceful figure, kindly bluish eyes, golden hair, a clear skin, a smile like a child's and giving the impression of "freshness, health and softness, softness, softness," a man "recognizable at a glance as the son of a sedate aristocratic family, the type of the fine young *pomyeshchik*, born and reared in our wide steppe-like regions." On his way home from Europe to Russia he is detained for a few hours at Frankfurt-am-Main, and by chance drops into a confectioner's shop conducted by the widow of an Italian Revolutionist. It happened that just at that moment Emilio the only son had fainted and his sister, Gemma, a young girl of exquisite beauty appeals to Sánin to bring him back to life. This the young man does; the family are profuse in their expressions of gratitude and persuade him to remain for a few days in Frankfurt. During a Sunday excursion with the two young people and Grüber, a bumptious and conceited German clerk to whom Gemma is betrothed, an intoxicated officer, Baron von Dönhof, insults the young girl, and when her lover shows no spirit to resent it, Sánin impulsively takes it upon himself to provoke the inevitable duel. This duel is described at considerable length with a wealth of comic detail. Neither party is injured and the Russian and the Baron part almost friends.

It results, however, in Gemma's breaking her engagement with the ridiculous and pusillanimous Grüber, but Signora Roselli begs Sánin to use his influence with her daughter to persuade her not to ruin her prospects and reputation by such an act, an engagement being regarded in Germany as no less sacred than marriage itself. Sánin reluctantly undertakes to fulfil this delicate mission but finds it impossible, since he has himself fallen in love with the beautiful girl and she is no less fascinated with him. He decides to sell his estate in Russia and invest money in the widow's confectionary business. By another turn of fate he meets at this moment his former schoolmate, Pólozof, another type of the lazy, easy-going Russian, who is married to an enormously rich young woman. Pólozof tells Sánin that his wife will perhaps buy his estate and offers him a place in his carriage to Wiesbaden where Márya Nikoláyevna is taking a cure. She is beautiful but unscrupulous and plays all her arts to fascinate Sánin, who weakly yields and never returns to Gemma. Thirty years later Sánin, always unhappy in his remorse for his dastardly behavior finds a little garnet cross which Gemma had given him. It brings up all the details of his soul's tragedy. He goes to Frankfurt and through Baron von Dönhof learns that Gemma had married a rich American. He writes to her and when she replies, enclosing a photograph of her own daughter, he sees in the picture the very image of his lost love and sends her the garnet cross together with a magnificent string of pearls. Gemma is the very ideal of sweet girlish purity and charm and is presented in striking contrast with the fascinating and not unsympathetic Russian siren who ruins men for her selfish amusement. It is an amusing and yet rather repulsive story. Originally published in the *European Messenger* (*Vyestnik Yevropui*) in 1872, it has been translated as 'The Torrents of Spring' by Constance Garnett (1897); 'Spring Freshets' by Isabel F. Hapgood (New York 1904); 'Spring Floods' by S. M. Butts (1874–75), and by E. Richter (London 1896).

NATHAN HASKELL DOLE.

TORRES NAHARRO, B. de., Spanish dramatic poet: b. near Badajoz, about 1500. He is called the creator of Spanish comedy and was the first writer of his time to develop fully his plots. He wrote fluently in both poetry and prose and his collected works were dedicated to Ferdinand d'Avalos, the husband of Vittoria Colonna. It was not until 1520, however, that his plays became known in Spain where they were very popular.

TORRES (tŏr'rĕs) **STRAIT,** the narrow channel which separates Australia and Papua. From Cape York on the northern coast of Australia to New Guinea it measures about 80 miles. Navigation is unsafe owing to the shoals, islands and reefs within its waters. It was discovered in 1606 by a Spanish navigator from Peru.

TORRES VEDRAS, tŏr'rĕs vā'drās, Portugal, a town in the district of Lisbon, situated on the railroad, 25 miles north of Lisbon. It is noted for its extensive lines of fortifications, 28 miles long, reaching to the Tagus River, and protecting 500 square miles of territory. They were begun in 1809, and behind them Wellington in 1810 checked the French advance toward Lisbon. It has hot sulphur baths and an old Moorish citadel. Pop. about 8,000.

TORREY, tŏr'ĭ, **Bradford,** American naturalist and author: b. Weymouth, Mass., 9 Oct. 1843; d. 1912. He was educated in the public schools, taught two years, entered business in Boston, and for many years after 1886 was a member of the editorial staff of the *Youth's Companion*. He has been well ranked as a field ornithologist, and writes entertainingly of his observations. His essays have been collected into the following volumes: 'Birds in the Bush' (1885); 'The Foot-Path Way' (1892); 'A Florida Sketch-Book' (1894); 'Spring Notes from Tennessee'; 'A world of Green Hills' (1898); 'Every-Day Birds' (1900); 'Nature's Invitation' (1904); 'Friends on the Shelf' (1906); 'Field Days in California' (1913).

TORREY, Charles Cutler, American Semitic scholar: b. East Hardwick, Vt., 20 Dec. 1863. He was educated at Bowdoin College where he taught Latin (1885–86). He studied at Andover Theological Seminary (1886–89) and at the University of Strassburg (1889–92) where he took his Ph.D. degree. Since that time he has been instructor in Semitic languages at Andover (1892–1900), director of the American School of Oriental Research in Palestine (1900–01), editor *Journal* of the American Oriental Society (1900–07; 1911–16) and president of the society (1917–18). His publications include 'The Commercial-Theological Terms in the Koran' (1892); 'Composition and Historical Value of Ezra-Nehemiah' (1896); 'The Mohammedan Conquest of Egypt and North Africa' (trans. from the Arabic, 1901); 'Selections from Bokhari' (1906); 'Notes on the Aramaic past of Daniel' (1909); 'Ezra Studies' (1910); 'Composition and Date of the Arts' (1916). Since 1900 he has been attached to Yale College.

TORREY, Charles Turner, American anti-slavery reformer: b. Scituate, Mass., 21 Nov. 1813; d. Baltimore, Md., 9 May 1846. He was graduated at Yale in 1830, entered the Congregational ministry, and held pastorates at Princeton, N. J., and Salem, Mass. Having removed to Maryland to promote the cause of anti-slavery, he became an active agent of the Underground Railroad (q.v.), and was arrested and imprisoned in 1843 for his report of a slaveholders' convention held in Baltimore. The following year he was again arrested, and being convicted of aiding in the escape of runaway slaves, he was sentenced to a long term in the penitentiary. The harsh treatment he received while undergoing his sentence brought on consumption from which he died, and his remains were taken to Boston where he was honored by a public funeral. He was regarded as a martyr in the cause of abolition, and "Torrey's blood crieth out," became an anti-slavery watchword. He wrote 'A Memoir of William R. Saxton' (1838), and while in prison produced a volume of sketches of Massachusetts life, 'Stone, or the Pilgrim's Faith Revived' (1846). Consult Lovejoy, 'Memoir of the Martyr Torrey' (1847).

TORREY, John, American botanist: b. New York, 15 Aug. 1796; d. there, 10 March 1873. He received his first instruction in botany, mineralogy and chemistry from Amos Eaton, and was graduated at the New York College of Physicians and Surgeons in 1818. His leisure from medical practice he devoted to scientific pursuits, particularly to botany, and in 1824 he abandoned medicine and became professor of chemistry, mineralogy and geology at West Point. From 1827 to 1855 he was professor of chemistry and botany at the College of Physicians and Surgeons, serving simultaneously at Princeton. From 1853 until his death he was chief assayer in the United States Assay Office, New York. He participated in the councils of Columbia College as trustee, and in 1860 presented to that institution his extensive herbarium and botanical library. In his special field of scientific research his publications were numerous. One of his earliest was a 'Catalogue of Plants Growing Spontaneously Within Thirty Miles of the City of New York' (1819), which he prepared for the New York Lyceum of Natural History (now the New York Academy of Science), of which he was a founder and for many years president. In 1843, as botanist of the Geological Survey of New York, he published an elaborate work on the flora of that State. Meantime he had issued in connection with Asa Gray (q.v.), parts of a work on 'The Flora of North America'; but this was also discontinued after the completion of the order *Compositæ*. From 1845 onward he published memoirs and reports on the botanical specimens brought back by expeditions to various parts of the West and South by Capt. John C. Fremont and others, among them being reports on the botany of the expeditions for ascertaining the most practicable route for a Pacific railroad and making the Mexican boundary survey. He was president of the American Association for the Advancement of Science in 1855, and was named by Congress in 1863 one of the original members of the National Academy of Sciences.

TORREY, Joseph, American clergyman: b. Rowley, Mass., 2 Feb. 1797; d. Burlington, Vt., 26 Nov. 1867. He was graduated at Dartmouth in 1816 and at Andover Theological Seminary in 1819. He was for a time pastor of a Congregational church at Royalton, Vt., but in 1827 became professor of Greek and Latin at the University of Vermont. In 1842 he took the chair of philosophy there, and in 1862–66 was president of the institution. He translated Neander's ‹General History of the Christian Religion and Church› (1854), and edited ‹Remains of President James Marsh› (1843) and ‹Select Sermons of President Worthington Smith› (1861). A volume of his lectures, ‹A Theory of Fine Art,› appeared posthumously (1874).

TORREY, Reuben Archer, American evangelist: b. Hoboken, N. J., 28 Jan. 1856. He was educated at Yale College and at Leipzig and Erlangen in Germany He was ordained as a Congregational minister in 1878, was superintendent Minneapolis City Mission Society and became associated with Dwight L. Moody in 1889 and served as superintendent of the Moody Bible Institute until 1908. In 1902–03 he made an evangelistic tour of the world. His life has been devoted to evangelistic work in many lands and he has written much on Bible subjects which have been translated in a score of languages.

TORREY BOTANICAL CLUB, a botanical society in New York which is the most important organization of its kind in America, and one of the six scientific societies affiliated in the Scientific Alliance. The club was an outgrowth of a former club, chartered in 1871. This band met in the herbarium of Columbia College, «drawn there by the genial welcome and wide botanical knowedge of its presiding spirit, Dr. [John] Torrey,» and was the nucleus of the present club, finally organized under its present name, complimentary to Dr. Torrey, in 1873. Dr. Torrey was the first president, but, unfortunately, died almost immediately.

The Torrey Club is the centre of botanical interest in New York, and the neighborhood, and is especially valuable for its weekly excursions that may be joined by any botanist, and which take parties out to good botanizing localities under intelligent guidance. Many local floras have been compiled by members of the club, one of the most important of which is that of Dr. Britton and others, ‹The Preliminary Catalogue of Anthophyta and Pteridophyta growing within 100 miles of New York.› The valuable herbarium of the club includes the material for this list, and specimens of the flora, within the same area. It is now deposited at the New York Botanical Garden, which was originated and developed by members of this society. The club issues three regular publications, namely: *Bulletin,* a very scientific and widely known journal; *Torreya,* of more popular scope; and *Memoirs,* which include many valuable monographs.

TORRICELLI, tŏr-rē-chĕl'lē, **Evangelista,** Italian mathematician and scientist: b. Faenza, Italy, 1608; d. Florence, October 1647. He early devoted himself to mathematical studies, and having read Galileo's ‹Dialogues,› composed a treatise concerning motion according to his principles. Galileo having seen this, conceived a high opinion of the author, and engaged him as his amanuensis. He accordingly went to Florence in October 1641, but Galileo dying three months after, Torricelli was about to return to Rome, when the grand duke of Tuscany, Ferdinand II, engaged him to continue at Florence, giving him the title of ducal mathematician and the promise of a professorship in the university on the first vacancy. Torricelli's name is important in the history of science as the discoverer of the natural law according to which fluids rise in an exhausted tube from an open vessel exposed to the pressure of the atmosphere, namely, that the weight of the fluid which rises in the tube is equal to the weight of an equal surface of atmospheric air of the height of the atmosphere. He also improved the telescope and microscope. See BAROMETER.

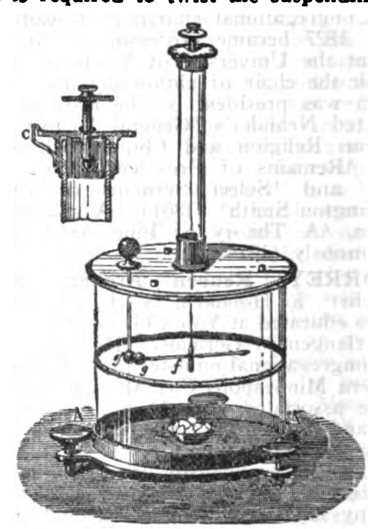
TORRICELLIAN EXPERIMENT, The, so called because made by the Italian physicist, Evangelista Torricelli (q.v.), who discovered the principle upon which barometers are made. Torricelli was led to investigate Galileo's theories of the law that «nature abhors a vacuum.» He filled a glass tube, closed at one end, with mercury, and placing his finger over the open end inverted the tube. He now placed the tube vertically in a small trough containing mercury and removed his thumb from the open end, after it was under the surface of the mercury. The mercury in the tube dropped until it stood at a height of about 30 inches. Here it rested, with a vacuum in the top of the tube, under the closed end. Torricelli concluded that the column of mercury in the tube was sustained by the pressure of the atmosphere on the larger surface of the mercury in the trough and that the height of the column was in inverse ratio to its specific gravity. Other experiments confirmed this theory and led to the invention of the barometer (q.v.).

TORRIGIANO, Pietro, pē-ä'trō tŏr-rē-jä'nō, Italian sculptor: b. about 1470; d. Spain, 1522. He went to England in 1509 to erect the tomb of Henry VII and his queen, still in Westminster Abbey. The works which he executed for English churches were destroyed by the Puritans. He was given a commission to make a statue of the Virgin Mary, and receiving what he considered an inadequate price destroyed it. For this he was imprisoned by the Inquisition, and there starved to death.

TORRINGTON, Frederick Herbert, Canadian musician: b. Dudley, England, 20 Oct. 1837, and was educated there. When but 16 years of age he was made organist (1853) at Saint Anne's Church at Bewdley, England, and in 1857–69 he held a similar position at Great Saint James Street Methodist Church, Montreal, Canada. He then went to Boston where he was organist in Kings Chapel (1869–73) and professor in the New England Conservatory of Music. Returning to Canada he became organist of the Metropolitan Church at Toronto and conducted the Philharmonic Society there and founded (1886) the first Toronto musical festival. Two years later (1888) he founded the first college of music. He was elected president of the Canadian Society of Music in 1892. In 1895 and 1896 he conducted musical festivals at Toronto and in 1903 was assistant conductor of the cycle of musical festivals in that city.

TORRINGTON, tŏr'ĭng-tŏn, Conn., borough in Litchfield County, on the Naugatuck River, and on the New York, New Haven and Hartford railroads, about 23 miles west of Hartford and 18 miles north of Waterbury. Settlements were made in the vicinity in the early part of the 18th century, and in 1740 Torrington was incorporated. In 1887 it was chartered as a borough. It is the birthplace of John Brown (q.v.). The borough has a number of manufacturing establishments; chief among which are bicycle and machine shops, plating-works, brass-works, woolen mills and novelty works. It also manufactures needles, hardware and tobacco products. In 1914 there were 54 manufacturing establishments, with a capital of over $16,000,000, and annual products of over $14,000,000, with payrolls of about $2,500,000. The principal public buildings are the churches, schools and the Young Men's Christian Association building. The educational institutions are a high school, public and parish schools, several private schools and a public library. There are two banks. The borough is the commercial and industrial centre of the town of Torrington, which contains 20,000 inhabitants.

TORSION BALANCE, an instrument in which small forces are measured by noting the torsion that they can produce in a fine wire or a delicate fibre of some other material. The invention of the instrument is usually ascribed to Coulomb (1736–1806), who employed it in his extensive researches on electricity. Cavendish also made use of it for the purpose of determining the mass of the earth; his experiment consisting in determining the attractive power of a pair of leaden spheres, and comparing this with the attractive power of the earth itself. In its conventional form, the torsion balance consists of a light horizontal arm, suspended at the centre by the fibre whose torsion is to measure the force that is applied to the arm. Quartz is now extensively used for the suspending fibre, its employment having been suggested by C. V. Boys, who showed how to prepare fibres of this material, which are very strong and elastic. Boys dipped an arrow into melted quartz and then shot the arrow from a bow; the quartz being thereby drawn out into a fibre of exceeding fineness. The upper end of the torsion fibre is attached to a graduated head, by whose rotation the fibre can be twisted through a known angle. In applying the torsion balance to the measurement of electrical repulsions, the horizontal arm, *f*, is provided at one end with a light ball, *g*, which can be charged to a definite electrical potential, and the torsion head is turned so that this ball is brought to a known distance from a similar fixed ball, *g'*, which can also be charged. The reading of the graduated head being observed when the fibre is fre from torsion and the balls, *g g'*, are at a known distance from each other, the balls are charged. They at once separate, owing to the repulsive action exerted between two electrical charges of the same sign. The graduated head is then turned so as to produce a torsion on the suspending fibre, tending to restore the balls to their original position. The twisting of the head is continued until the relation of the balls is the same as at first; and when this state is established, it is evident that the torsion of the fibre is exactly balanced by the repulsion of the charges. In order to deduce the electrical repulsion in definite measure, it is only necessary to determine, by a separate experiment, what force is required to twist the suspending fibre



Torsion Balance.

through one entire turn; and a simple proportion then gives the repulsive force desired. The application of the torsion balance to experimental work of other kinds will be readily understood from the foregoing description of its application to the measurement of electrical repulsions; for the principles involved are the same in all cases, the force that is to be measured being determined by noting the torsion required to neutralize it, in a fibre whose torsional constant has been determined by direct comparison with a known force. The fact that the torsional moment of a homogeneous twisted fibre is proportional to the angle through which the fibre is twisted was established experimentally by Coulomb. In actual service the torsion balance is surmounted by a case of metal or glass, the air in which is kept dry by a dish containing calcium chloride, or phosphorus pentoxide or pumice stone wetted with concentrated sulphuric acid or some other powerful and non-volatile drying agent.

The name "torsion balance" has also been applied to a form of commercial balance in which the pans that contain the weights and the objects to be weighed are supported, not upon knife edges, but upon the middle points of narrow, thin, horizontal ribbons of stretched steel, in such a manner that when the balance descends at either end, the steel ribbons are exposed to a torsional moment which tends to restore the balance to the normal position of equilibrium.

ALLAN D. RISTEEN.

TORSIONAL RIGIDITY, that species of rigidity by which a cylindrical bar of any material resists the action of a force (or «couple») which tends to twist the bar in such a manner as to convert its originally straight, longitudinal elements (or fibres) into a helical form. The torsional rigidities of a pair of cylindrical bars of identical dimensions but composed of different substances may be compared by comparing the twisting moments that are necessary in order to twist both of them through the same small angle. If one end of such a cylindrical bar is held fixed, while the other end is twisted by a lever applied to it after the manner of a wrench, the angle x, through which the bar will be twisted, is given the formula $x = \frac{CLPR}{D^4}$; L being the length of the bar that is twisted, D being its diameter, and C being a constant peculiar to the material of which the bar is composed; while P and R are respectively the twisting force, and the length of the lever to the end of which this force is applied. The minimum diameter that a shaft should have, in order to transmit a given horse power safely, may be calculated by the following formula: $D = F \sqrt[3]{H/R}$, where D is the diameter of the shaft in inches, H is the number of horse power to be transmitted, R is the number of revolutions of the shaft per minute, and F is a numerical factor peculiar to each kind of material. For wrought iron, F may be taken as about 4, and for steel it may be taken as 3.8. Consult Kent, 'Mechanical Engineer's Pocket Book'; Rankine, 'Applied Mechanics.'

TORSK, a Scandinavian species of cod. See CUSK.

TORSO, an art term applied to the trunk of a statue of which the head and limbs are wanting, or to the trunk of a statue considered independently of the head and extremities; also to the trunk or thorax of a model. Many examples of ancient sculpture recovered in the last five centuries have been incomplete in this manner. The most famous is the Torso Belvedere, a torso of a statue of Hercules, seated. It derives its name from the Belvedere, at Rome, in the Vatican Palace where it is preserved, and is attributed to the school of Lysippus, being believed by some authorities to be the work of that master, although a Greek inscription ascribes it to the artist Apollonius. It is considered by connoisseurs one of the finest works of art remaining from antiquity.

TORSTENSSON, tŏr'stĕn-sŏn, **Lennart,** Swedish general: b. Torstena, 17 Aug. 1603; d. Stockholm, 7 April 1651. At 14 he became a page at the court of Gustavus Adolphus and in 1630 accompanied him to Germany as captain of the bodyguard. He was commander of artillery at the battle of Lech, 5 April 1632, was taken prisoner before Nuremberg in August and confined for six months in a subterranean dungeon in Ingolstadt. In 1641 he was appointed commander-in-chief of the Swedish army in Germany. He defeated the Archduke Leopold and Piccolomini at Breitenfeld, 2 Nov. 1642, threatened Prague and relieved Olmütz in 1643, and after the declaration of war by Denmark in December he advanced into that country and in six weeks had conquered the whole peninsula with the exception of the fortresses Rendsburg and Glückstadt. He defeated the Austrian general, Gallas, at Jüterbok, 4 Nov. 1644, and Katzfeld at Jankau, 6 March 1645, pushed through Moravia to the Danube and destroyed the fortifications on Wolfsbrücke before Vienna. His siege of Brünn was unsuccessful owing to the stubborn defense and a pestilence among his troops, and after withdrawing into Bohemia, in 1646, he was compelled by illness to resign his command. He was made Count of Ortaba and governor-general of West Gothland by Queen Christina in 1647.

TORT is a legal term indicating an injury or wrong; tort may be committed with force, as trespass which may be an injury to the person, such as assault or false imprisonment or to property in possession, or a tort may be committed without force, such as an injury to one's character or affecting one's personal liberty. One may be liable in damages for a tort, but same is distinguished from a similar right growing out of a contractural relation. An action in tort is a civil action which undertakes to discover if a wrong or crime is involved. A misappropriation of funds by a trustee, for example, must be inquired into before it can be certainly known: (1) that the fund is short; (2) that the defendant is responsible for the shortage; (3) whether there is a question as to the amount of the misappropriation; (4) whether the defendant simply owes such shortage, or (5) whether he stole it, and should be arrested. Actions in tort are common in cases of breach of contract, libel, trespass, conversion, assault, negligence resulting in accident, etc. Consult Burdick, F. M., 'The Law of Torts' (1905); Bohlen, F. H., 'Cases in the Law of Torts' (1912).

TORTICOLLIS, twisted neck, an affection in which, while the head is bent usually toward one of the shoulders, the twisting of the neck turns the chin to the opposite side. In this condition, known in various forms as stiff-neck or wryneck, lateral movement of the head often causes great pain, especially when the affection is due to rheumatism (q.v.). This attacks the muscles lying on the side of the neck, especially the sternomastoid. In the great majority of cases only one side of the neck is affected, the head being drawn more or less obliquely toward that side; but occasionally, in a form more strictly to be regarded as stiff-neck, both sides are equally attacked, in which case the head is kept stiffly erect and looking straight forward. As long as the head is allowed to remain at rest there is merely a feeling of discomfort; but every movement is apt to be extremely painful. This affection is usually caused either by exposure of the part affected to a current of cold air, or by wearing wet or damp clothes round the neck, but may also arise from spasm or strain of the muscles of the neck, causing a crick. It is usually temporary, but in some cases muscular contraction renders it permanent.

TORTOISE. See BOX-TURTLE; LAND-TORTOISE; TERRAPIN; TURTLES.

TORTOISE PLANT, a loft climber (*Testudinaria elephantipes*) of southern Africa, resembling a yam, and belonging to the same family. It has slender twining stems, alternate, netted-veined leaves, small diœcious bell-shaped yellowish flowers in axillary racemes, and triple-winged capsules. It is, however, characterized by its globular rootstock, sometimes four feet in diameter, and growing above the ground. This enormous tuberous structure is woody or succulent, and is covered with a soft corky bark, which, cracking by exposure, becomes tessellated with angular protuberant plates suggestive of those of the tortoise. When young it has also suggested the name of elephant's-foot, and its utilization as a food by the natives has given rise to the title Hottentot's-bread.

TORTOISE-SHELL, the material of the large epidermal scales of the hawksbill sea-turtle (*Chelone imbricata*). Thirteen of these plates cover the carapace, and instead of being joined together by their edges so as to make apparently one piece, are thinned off at their posterior margins, and overlap each other like the tiles of a roof. They vary in size according to the part of the shield they occupy. The larger are sometimes from a foot to 18 inches long by six inches broad; the thickness rarely exceeds the eighth of an inch. The beautiful mottled color and semi-transparent characters of this material are well known. A remarkable quality is possessed by tortoise-shell which very greatly increases its usefulness for the ornamental purposes to which it is generally applied, that is, the property of being easily softened by a heat equal to boiling water, and of retaining any form when cold which has been given to it when heated. Pieces can also be welded together by the pressure of hot irons properly applied. The chief use of tortoise-shell is in making combs for the hair; but it is also used for inlaying ornamental furniture and various other fancy objects. By the French cabinet-maker Boule (see BUHLWORK) it was used most effectively in combination with brass as a veneer for rich furniture, and all boule or «buhl» work consists of such a veneering combination. In India, China and Japan many articles are made of it, showing great skill and taste.

TORTOISE-SHELL BUTTERFLY, a butterfly of the genus *Vanessa* as the Camberwell beauty (q.v.), in reference to the reddish-brown, black and white coloration.

TORTOLA, tôr-tō'lą, one of the Virgin Islands, West Indies, lying northeast of the island of Saint John, from which it is separated by a narrow channel; area, 24 square miles. It is hilly and rugged, the highest elevation being 1,600 feet. Only a small part of the land is cultivated, cotton and sugar are raised, and sugar, molasses and rum exported. The island is one of the most important of the Virgin group and contains the chief town, Roadtown.

TORTOSA, tŏr-tō'sä, Spain, a city in Catalonia, 45 miles southwest of Tarragona and 100 miles southwest of Barcelona, on the Ebro River. Its ports are El Fangar and Los Alfaques at the mouth of the river. It occupies an acclivity rising from the left bank, and is fortified, part of the walls being of great antiquity. There are several small squares, and the streets are narrow and crooked, some of them very steep. The houses are built of solid masonry, there is a cathedral and other churches and a monastery. There are manufactures of soap, paper, hats, leather, porcelain, faience, and important fisheries. In the vicinity are fragments of Roman ruins, also marble and alabaster quarries. Pop. about 26,000.

TORTRICIDÆ, a family of moths. See LEAF-ROLLER; MOTH.

TORTUGAS, tôr-too'gaz. See DRY TORTUGAS.

TORTURE, as a means of judicial punishment, descended to the countries of modern Europe from the Greeks and Romans since it appears not to have been practised by the Hindus, the Hebrews or the Egyptians. Torture was judicialy inflicted either to extort confession, purge sin, or aggravate punishment. As practised by the Greeks, it was not applicable to a freedman, except in certain cases, but was commonly applied to slaves. Indeed the word of a slave could not be admitted as testimony, except under torture, and either party to a controversy could demand the torture of his opponent's slaves. The principal modes of torture with the Greeks were the wheel, the rack, the sharp comb, the burning tiles, the vault (into which the victim was bent double), and the injection of vinegar into the nostrils. From the Greeks the Romans got their system of torture and from the Roman laws it was engrafted in the judicial systems of all the modern countries of Europe. The Romans, like the Greeks, exempted freedmen from the horrors of torture, except in cases of treason. But under the emperors the torture of a freedman was not an infrequent occurrence. The Romans chiefly employed the rack, the scourge, hooks for tearing the flesh, and fire in its various uses. Roman contact with barbarian races gave the practice to the latter, but with one exception it made slow headway in replacing the older and more superstitious custom of the ordeal. That exception is in the case of the Visigoths who established a system of torture that remained uninterrupted from the time of their settlement in Spain to modern times, and which furnished a model upon which most of the other European systems were based. Legalized torture became common in France during the first part of the 13th century and in Germany a century later. English lawyers assert that it was never legalized in Great Britain, but certain it is that it was commonly practised, and, if not directly enjoined, was at least sanctioned by the laws of that realm. All Europe came under the system during the 15th century, in consequence of the systematization of the Inquisition (q.v.), and the growth of that institution in power and importance, and with the exceptions of Great Britain and Sweden, torture formed a recognized department of the jurisdiction of European nations until the end of the 18th century. During the time of the Inquisition torture was applied by the civil, not by the ecclesiastical, court, and the ecclesiastics present at the question were there simply as witnesses of the confession and not as agents, as popular fancy has pictured them. A confession extorted by torture was of no avail to the prosecution before an ecclesiastical tribunal, unless it was voluntarily confirmed three days afterward. From the 13th century on, the use of torture increased, until its extreme cruelty and the horror of its practice led to a revulsion of feeling and to its general abandonment in the latter half of the 18th century. In some countries, however, it continued to be officially recognized and sporadically employed until the early part of the 19th century. It was abolished in Saxony in 1783, in Russia in 1801, in Würtemberg and Bavaria 1806–07, in France in 1789 (although it was employed in 1814), in Hanover in 1819, and in Baden in 1831. It is believed, however, that it was practised in Russia even early in the 20th century. It never was sanctioned in the United States, though "witches" were burnt near Salem, and the burning of negroes for rape by lynch law still persists. Consult Lea, H. C., 'Superstition and Force' (1870); Pearsall, R. L., 'The Kiss of the Virgin,' etc. (1838); Sassen, M. J., 'Disputatio de abusu et usu torturæ' (1697); Parsons, 'Studies in Church History' (Vol. II, Art. "Inquisition," 1895). See INQUISITION; RACK.

TORU DUTT, tō'roo doot. See DUTT, TORU.

TORY, Henry Marshall, Canadian minister and educator: b. Guysboro, Nova Scotia, 1867. He was educated at the local academy and at McGill University where he was graduated in 1890 with high honors in mathematics and physics. He studied theology at Wesleyan University and entered the Methodist Church in 1889 but retired in 1892 to become lecturer in mathematics in McGill University and was professor there until 1908 when he was chosen president of the Provincial University of Alberta at Strathcona. He published 'A Manual of Laboratory Physics' (1902).

TORY, the name of a political party, used in Great Britain and other Anglo-Saxon countries, is said to have originally been applied to the Roman Catholic outlaws who lived in the bogs of Ireland during the reign of Charles II. The name became identified with the opponents of the bill excluding the Duke of York from the English succession (1679), and was thus intended to imply Roman Catholic sympathies on the part of the duke's adherents. It was transferred to the court party in English politics, their opponents being classed as Whigs. Since the clergy of the Church of England taught the doctrines of passive obedience and the divine right of kings, they also were known under the name of Tories. In modern English politics the successors of the Tory party are known as Conservatives, but the old term is not infrequently heard in Parliamentary debate. Political parties in British colonies at times followed closely the divisions and names in England, so that in Australia and New Zealand the conservative elements in the representative assemblies were known as Tories. In the American colonies the name was given to the adherents to the policy of the mother country, and during the Revolutionary War was applied to all persons suspected of British sympathies. Consult Bentinck, Lord Henry, 'Tory Democracy' (London 1918).

TOSCANELLI DAL POZO, Paolo, tŏs'-ka-nél'lē dăl pŏt'sŏ, Italian geographer: b. Florence, Italy, 1397; d. there, 1482. He believed that India could be reached by sailing to the westward and so advised Columbus in 1474. He also gave the king of Portugal similar views. It is thought that he strengthened the views of the great navigator to undertake the western voyage, although not alone in doing this. Consult Vignaud, Henry, 'Toscanelli and Columbus' (New York 1902).

TOSTI, Sir Francesco Paolo, frăn-chĕs-kö päölö tŏs-tē, Italian composer: b. Ortona di Mare, 7 April 1847; d. 1916. He was a pupil and later teacher at the Conservatorio Reale, Naples, and in 1869 appeared as a concert singer at Rome. Shortly afterward he became vocal instructor at the court; removed to London in 1875 and in 1880 was appointed instructor to the royal family. He produced 'The Grand Duke' (opera, 1888); 'La prima donna' (opera, 1889) and many English and Italian songs. His 'Good-bye'; 'For Ever and For Ever'; 'That Day,' etc., are widely popular. He was knighted in 1908.

TOSTIG (TOSTI, TOSTINUS), West-Saxon warrior: d. 1066. In 1055 he was made earl of Northumbria, Northamptonshire, and Huntingdonshire, by Edward the Confessor. A stern ruler, he repressed feud and disorder by the exercise of a merciless justice (*patriam purgando talium cruciatu vel nece*), with no distinction of rank. In 1063 he joined his brother Harold in the invasion of Wales, but in 1064, for treacherous murder, was outlawed, while Morcar was chosen to the earldom (1065). He retired into exile in Flanders, in 1066 committed various depredations on the Isle of Wight, Lindesey and the east coast and subsequently joined Harold Hardrada, king of Norway, in an invasion of England. They landed in Yorkshire, but were entirely overthrown by Harold and his household troops at Stamford Bridge. Tostig figures in Tennyson's drama of 'Harold' (1877). Consult Green, 'The Conquest of England' (1884); Freeman, 'History of the Norman Conquest' (Oxford 1887).

TOTARA, or TOTARRA, a tree (*Podocarpus totara*) of New Zealand, of the yew family, excelled only by the kauri for general utility, and most abundant in the central part of North Island. It is from 60 to 80 feet in height and has a fibrous brown bark which is deeply furrowed and was used by the natives for roofing their huts. Its leaves are linear and of a greenish-brown color. The wood is reddish-brown, clear and straight in the grain and does not warp or twist. It is largely used for furniture, cabinet-work and house-building, but is particularly valuable for bridges, wharves and marine piling, as it is durable under the ground or water and resists the attacks of teredos for a long time. The aborigines made canoes from the trunks of these trees. See PODOCARPUS.

TOTEM, a word which appears to have been applied originally to the animal or other thing held sacred by certain American Indians as the sign or symbol of the tribe or of an individual Indian. The superstition is not confined to American Indians and has its counterpart in the symbols of civilized nations. The American eagle, the lion of Great Britain, the thistle of Scotland, the rose of England, etc., and the arms of noble families are illustrations.

The practice can be traced, indeed, throughout all history, among the greatest empires and the most savage tribes.

The totem superstition varies in its features in different countries. The members of the Emu clan of an Australian tribe believe themselves to be descended from the emu and are regarded as forming a kind of blood-group in virtue of their common descent. No member is permitted to marry within the clan, and all the members are bound to support one another in times of necessity. No Emu clansman will knowingly kill or eat an emu. Among some savage peoples the dead totem is elaborately mourned and carefully buried. Besides clan totems there are sex totems and individual totems. The totem having an important bearing on a person's relations to his fellows, it is shown conspicuously, being often tattooed on the skin or otherwise. The importance of totemism in relation to the social and religious institutions of savage peoples was first pointed out by J. F. M'Lennan in 1868 and much fresh light has been shed on the subject by subsequent investigators but no satisfactory explanation of this curious system has yet been advanced. The American Indians were given to totemism and not only set up various animal figures as emblematic of their tribes but individuals were frequently named after animals. The exact meaning and character of their totem practices is little understood. There were rules as to all marriages of those in kindred totems; some took their totems from their fathers, some from their mothers and some from their tribe. Totemism exists also among many African peoples, and numerous instances of it are to be met with in Asia and Polynesia. (See AFRICA; AUSTRALIA; INDIANS, AMERICAN). Consult Lang, A., 'The Secret of the Totem' (1905); Frazer, 'Totemism' (1887); Durkheim, E., 'Elementary Forms of the Religious Life' (Eng. trans., London 1915).

TOTEM POLE, a pole used among North American Indians to exhibit the totem figures. The totem pole is composed principally of three half human, half animal figures, seated above one another and holding erect a pole on the summit of which, for instance, is the totem. See TOTEM.

TOTONICAPAM, tō-tō-nē-kä-päm'. Guatemala, the capital of the department of the same name, situated 60 miles northwest of the city of Guatemala. It manufactures cloth, pottery and wooden implements. It was half destroyed by an earthquake in 1902. The population, consisting almost entirely of Quiché Indians, is about 28,000.

TOTTEL, Richard, English printer and publisher: b. about 1525; d. 1594. He was granted a patent in 1553 to print law books, which was extended for life in 1559. He also published the writings of the men of his day. He was a charter member of the Stationers' Company which he left in 1589 because of poor health. His most notable work was done in compiling and publishing the first poetic anthology in England, 'Tottel's Miscellany' (1557), which contained 271 hitherto unpublished poems. Among his other publications were the translation of 'De Officiis' by Grimaldi (1556) and the translation ot the second and fourth books of the 'Æneid' by Surrey (1557).

TOTTEL'S MISCELLANY. The work which commonly goes by this name was published under the title 'Songes and Sonettes, written by the ryght honorable Lorde Henry Haward [i.e., Howard] late Earle of Surrey, and other,' by the stationer Richard Tottel, on 5 June 1557. Its popularity was such that a second edition was issued in the following month and six others followed within the century. Tottel's method, too, was imitated by other editors and publishers and doubtless stimulated the vogue of what are now usually called the Elizabethan anthologies. In the address of "the Printer to the Reader," he alludes to the verse of well-known Latin and Italian poets, adding: "That our tong is able in that kynde to do as praiseworthy as the rest, the honorable stile of the noble earle of Surrey, and the weightinesse of the depe-witted sir Thomas Wyat the elders verse, with severall graces in sondry good Englishe writers, doe show abundantly." This passage indicates the real significance of the volume: namely, the effort which it represents to beautify English poetry and to show that the art of the Italians could be rivaled by the new courtly or cultivated school of British poets. Compare, to the same effect, a passage in a work called 'The Arte of English Poesie' (1589), attributed to one George Puttenham: "In the latter end of the same kings raigne [i.e., Henry VIII] sprong up a new company of courtly makers, of whom Sir Thomas Wyat the elder and Henry Earle of Surrey were the two chieftains, who having travailed into Italie, and there tasted the sweete and stately measures and stile of the Italian Poesie, as novices newly crept out of the schooles of Dante, Arioste and Petrarch, they greatly pollished our rude and homely maner of vulgar Poesie, from that it had bene before, and for that cause may justly be sayd the first reformers of our English meetre and stile."

Wyatt had died in 1542 and Surrey in 1547, but it was reserved for the publisher Tottel to secure manuscript copies of many of their poems and bring them out for the first time in print. These occupy the place of honor in the volume, being followed by poems attributed to Nicholas Grimald (who has been suspected of acting as Tottel's editor) and by those referred to "Uncertain Authors." A number of the poems in this last group can be identified, one of them, indeed, being a now familiar lyric of Chaucer's; but the majority remain anonymous, nor is any of these comparable to the best work of Wyatt and Surrey. The elements of familiarity and of novelty in the collection are perhaps best illustrated by the metrical form of the various poems. One finds, for example, the old "rhyme royal" stanza of Chaucer, and the loose, sometimes doggerel "septenary," or seven-foot line, which had been popular from the Middle English period; but side by side with these occur specimens of Italian forms not previously naturalized in English. Of these last the most noteworthy are certain poems in the great Italian form, the *terza rima,* and a considerable number of sonnets — the first in English poetry. Wyatt's sonnets, largely versions of Italian and French poems, follow the recognized continental types; while the younger poet, Surrey, seems to have undertaken to modify the form in the direction of English taste, with the resulting type of sonnet, in three quatrains and a couplet, which was to be the favorite in the Elizabethan age and the form chosen by Shakespeare. Outside the work of these two poets, the contents of the miscellany are of slight intrinsic value; but its historical importance is so marked that because of its publication in 1557 it is customary to date from that year the beginnings of modern English poetry.

A convenient modern edition of Tottel's Miscellany is that in Arber's 'English Reprints.' For accounts of the poetry of Wyatt and Surrey consult Courthope's 'History of English Poetry' and Padelford's 'Early 16th Century Lyrics' ('Belles Lettres Series).

RAYMOND M. ALDEN.

TOTTEN, tŏt'ĕn, **Charles Adiel Lewis**, American inventor and military instructor: b. New London, Conn., 3 Feb. 1851; d. Milford, Conn., 12 April 1908. He was graduated at West Point in 1873 and was instructor in military science and tactics at the Amherst Agricultural College, at the Cathedral School, Saint Paul, N. Y. and at Yale University. He patented improvements in high explosives, in collimating sights and in signal-shells; besides a system of weights and measures and improvements in linear and other scales. He patented a war game which he described in a publication entitled 'Strategos, the American War Game' (1880) and has also published 'Important Questions in Metrology' (1883). More recently he issued 'Lost Israel Found in the Anglo-Saxons' (1890) and 'Joshua's Long Day and the Dial of Ahaz' (1891).

TOTTEN, Joseph Gilbert, American military engineer: b. New Haven, Conn., 23 Aug. 1788; d. Washington, D. C., 22 April 1864. He was graduated from West Point in 1805, was engaged in a survey of Ohio and the western territories, and in 1806 resigned from the army. He re-entered the army in 1808, was reappointed second lieutenant of engineers and was in charge of the construction of Castle William and Fort Clinton in New York Harbor until 1812. He was chief engineer in the army on the Niagara frontier during the War of 1812, was brevetted lieutenant-colonel in 1814, and after the war was engaged in the construction of coast defenses until 1838 when he was promoted lieutenant-colonel and chief engineer in the army, and shortly afterward became supervisor and inspector of the United States Military Academy. At the outbreak of the Mexican War he was placed in charge of the engineering operations and in recognition of his services in planning the siege of Vera Cruz was brevetted brigadier-general in 1847. He then resumed his duties at Washington, but was appointed one of the commissioners for arranging the terms of capitulation. He became brigadier-general in 1863 and in 1864 was brevetted major-general. He published 'Essays on Hydraulics and Other Cements' (1842).

TOTTENHAM, tŏt'ĕn-ạm, England, a town of Middlesex, forming a residential suburb of London and situated some six miles north of the Tower of London, just outside of the city limits. It was a favorite resort of Isaak Walton. Among its most interesting buildings are an old church and Bruce Castle, an Elizabethan mansion formerly owned by Robert Bruce. Pop. 150,000.

TOTTENVILLE, formerly an incorporated village in Richmond County, N. Y.; since 1898 in New York City. See STATEN ISLAND.

TOTUAVA. See BLUEFISH.

TOUCAN, too-kän' or too'kạn, a family (*Rhamphastidæ*) of coccygomorphous birds somewhat resembling the hornbills, and distinguished by the great development of the bill, which is curved superiorly and bears a prominent keel, with cutting edges frequently toothed. The outer walls of the bill are extremely thin, its interior is hollowed out into air-cells, and it is thus rendered comparatively light. The tongue is slender and barbed along the sides. The toes are paired, two forward, two backward and the tarsi scuttelated, the wings rather short and the tail long, with 10 quills. The toucans are confined to tropical America, where about five genera and 60 species occur. They are birds of brilliant and striking plumage, and the bill and naked skin about the eyes partake of this brightness of hue. Most of the species are gregarious, spending most of their time in hopping actively about among the treetops and seldom flying far. The times of their greatest activity are the morning and evening, when the woods are filled with their loud harsh cries. While fruits are their chief food, insects and the eggs and young of birds are also eaten. They have a characteristic manner of throwing back the head and bolting their food. When sleeping the head and tail are turned toward each other and rest on the back. All of the species, so far as known, nest in holes in trees, the birds sometimes excavating a suitable place in a decayed stub. Only two white eggs are deposited.

The following are some examples of the species, many of which are familiar in the collections of zoological gardens. The toco toucan (*Rhamphastos toco*) is black with a black and orange bill, blue circumocular areas and white throat and rump. It is nearly two feet long and inhabits Argentina. A well-known relative is the ariel (*R. ariel*). The araçari (*Pteroglossus aracari*) is green with the head and throat black and the bill black and white. A related species (*P. beauharnaisi*) is dark green with the lower back crimson, the belly yellow and red and the bill black, orange and white. Both of these are found chiefly in the forests of the Amazon Valley. A well-known species is *Selenidera spectabilis*, in which the sexes are unlike. The hill toucan (*Andigena bailloni*) of the lowlands of Brazil, has the head, neck and lower parts orange yellow. Consult Sclater, 'Catalogue Birds British Museum,' XIX (London 1891); Bates, 'Naturalist on the River Amazon' (London 1863). See HORNBILL.

TOUCEY, tow'sĭ, **Isaac**, American jurist: b. Newtown, Conn., 5 Nov. 1796; d. Hartford, Conn., 30 July 1869. He received a private classical education, was admitted to the bar in 1818, and established a law practice at Hartford. He was State's attorney for Hartford County in 1822–25, served in Congress in 1835–39 and was again State's attorney in 1842–44. He was governor of Connecticut in 1846–47, and in 1848–49 was United States Attorney-General. In 1850 he was elected to the State senate and served in the United States Senate in 1852–57. He was appointed Secretary of the Navy by President Buchanan in 1857 and served until

1861. His conduct of naval affairs was severely criticized. He was accused of favoring the secession cause by scattering the best ships of the navy in distant seas. The charge was denied, though Toucey continued to be regarded as a sympathizer with the South.

TOUCH, the sense of feeling. See SENSES.

TOUCHSTONE, LYDIAN STONE, or **BASANITE**, a velvet-black jasper, used on account of its hardness and the uniformity of its texture and color as a streak tablet for determining the relative amounts of baser metal and pure gold in alloys. The sample is rubbed on the stone and the color is then compared with a series of standards of kown composition. The expert is able quite accurately to determine the fineness of the sample, the streak becoming redder as the proportion of copper increases, or yellower as the percentage of gold increases. This method of testing has been in vogue from the earliest times, the name Lydian Stone appearing as long ago as 450 B.C. Modern methods of assaying have now largely superseded the use of this stone.

TOULON, too-lon, France, a fortified seaport town and naval arsenal, in the department of the Var, on the Meriterranean, 42 miles southeast of Marseilles. The port is separated from the roadstead by bomb-proof moles and comprises two parts: one, including the merchant shipping; the other, the dockyard, slip, arsenal, foundry, etc. The fortifications are very complete. The cathedral was founded in 1096. This, the hôtel-de-ville and a capacious theatre are the chief of the old buildings; more recent are the Museé Bibliothèque, Marine School, library and observatory, the lyceum and botanical gardens. The Place de la Liberté contains a splendid monument to the heroes of the Revolution; Le Place d'Armes, the Boulevard Strasbourg and Jardin de la Ville are prominent promenades. It has modern fortifications of the first class and is headquarters for one of the five maritime arrondissements carrying stores for the Mediterranean fleet, with important shipbuilding interests. The bay or harbor is defended by torpedoes and commanded by six forts. On the hills north of the city very strong forts are located. Toulon was known to the ancients as Telo Martius or Telonion. The Saracens sacked the city in 889 and Charles V captured it twice in the 16th century. Louis XIV gave Toulon its importance as a naval station, making the dockyards and arsenal the finest of France. Toulon first became famous as a stronghold in the 16th century. Here the English were defeated by the fleets of France and Spain (1744); and in 1793 Napoleon forced the English and Spaniards to evacuate the position — his first memorable victory, while commanding the French Republicans. In time of peace about 600,000 tonnage is entered and cleared annually. The principal trade is in wines, fruits and oils. There are metal manufactories and lace works. Pop. about 107,000.

TOULMIN, Henry, American lawyer: b. Taunton, England, 1767; d. in Washington County, Ala., 11 Nov. 1823. He came to Norfolk, Va., in 1793 and in 1794–96 was president of Transylvania University. In 1796–1804 he was secretary of state of Kentucky and in the latter year was appointed judge of the United States District Court of Mississippi. He assisted in framing the constitution of the State of Alabama, in whose legislature he served. He was author of 'A Description of Kentucky' (1792); 'A Collection of the Acts of Kentucky' (1802); 'Review of the Criminal Law of Kentucky' (1804); 'Digest of the Laws of Alabama' (1823).

TOULOUSE, Edward, French alienist: b. Marseilles, France, 1865. He studied in Paris and became head physician of the asylum at Villejuif where he established a laboratory for experimental psychology. He founded the *Bibliothèque de Psychologie Experimentale* and other journals and was a writer of repute on his specialty. His chief publications were 'Organisation scientifique d'un service d'aliénés' (1900); 'Technique de psychologie expérimentale' (2 vols., 1905; 2d ed., 1911); 'Comment conserver sa santé (1914); etc.

TOULOUSE, too-looz, France, capital of the department of Haute-Garonne, 140 miles southeast of Bordeaux, on the Garonne. It is the centre of railway traffic and river and canal freight in southern France. A fine bridge connects the town with the village of Saint Cyprien. It is a quaint old town, but very enterprising. The most remarkable buildings are the cathedral, church of Saint Sernin, Hotel-de-Ville, museum and Palais-de-Justice. The Musee contains an almost unparalleled collection of objects d'arts from the Gallo-Roman to the Renaissance period. There are several fine academies of art, science and literature (one claiming its origin to have been in games of the troubadours of 1323, namely, Société des Jeux Floraux); professional and technical schools, a large public library of 225,000 volumes, an observatory and botanical garden. Toulouse is one of the larger cities of France, designated as the seat of a State university, which includes faculties of law, medicine, science, letters, etc. It has a library of over 150,000 volumes and nearly 5,000 students. There is also a large Catholic institution with theological, literary and scientific instruction. The old name of the city was Tolosa, dating back before the Christian era. It was sacked by Q. S. Cepio 106 B.C., and rebuilt and regarded as an important city in the 4th century. The Visigoths, under King Wallia, made it their capital in 419. It was taken by Clovis in 507, and was Charibert's capital in 630. For many hundred years it was the foremost city of southern Gaul. The Saracens took it in 718. The name developed into Toulouse about 780, where Charlemagne made his young son Louis, king of Aquitaine, with his capital there. About 850, the first Count of Toulouse established himself, and these nobles governed the city and southern France for over 500 years. The tribunal of the Inquisition was established at Toulouse. It was the scene of Hugenot massacres in 1562 and again in 1572. The manufactures include textiles, leather, cannon, steam-engines, tobacco, brandy, etc. In modern history, the most important event was its defeat by the English, while in ignorance of Napoleon's abdication. Pop. (1911) of commune 149,576, the town proper being about 23,000 less.

TOULOUSE, University of, celebrated French school of higher learning, founded by

Pope Gregory IX in 1230 as a protest against the Albigensian heresy. It was originally a theological school but became noted as a school of law and sided with royalty against the Church. At one time not less than 10 well-endowed foundations were included in it, but under the national system it now includes only the faculties of law, medicine and pharmacy, and science and philosophy. There also is the faculty of Protestant theology of Montauban and two free faculties of theology and philosophy. Its library is noted and contains considerably over 150,000 volumes.

TOULOUSE GOOSE. See GEESE.

TOUMEY, James William, American professor of forestry: b. Lawrence, Mich., 17 April 1865. He was educated at the Michigan Agricultural College in 1889, and was special student at Harvard in 1893. He was assistant in the department of botany in the Michigan Agricultural College (1890–91), professor of biology in the University of Arizona (1891–98), and finally entered the United States Forestry Service and became director of the Yale Forestry School in 1910. He is the author of several books on forestry and kindred subjects.

TOUR, Maurice Quenti de la, mō-rēs kŏn-tăn dė lā toor, French painter: b. Saint Quentin, 5 Sept. 1704; d. there, 18 Feb. 1788. He began his art studies in his native town and subsequently devoted himself to the execution of pastel portraits in Paris, in which city he gained such reputation that the most famous of his contemporaries gave sittings to him. In 1746 he was elected to the Académie He returned to his native town in 1784 and the Saint Quentin Museum now contains 80 portrait pastels of his. His 'Pompadour' is in the Louvre; and there are two other of his pictures in the Dresden Gallery. Consult Patoux, 'L'Œuvre de M. Quentin da la Tour au Musée de Saint Quentin' (1886).

TOURACO, a large and beautiful African bird of the genus *Corythaix;* with a short, rather small, high bill; both mandibles notched and finely serrated; short, rounded wings, with the three first quills graduated; a long rounded tail, short, strong feet and an erectile crest. Their prevailing color is green, with purple on the wings and the tail, the peculiar red of which is furnished by a special pigment called turacin. They feed on fruits, perch on the highest branches of trees. It is a member of the family of plantain-eaters (q.v.). Consult Newton, 'Dictionary of Birds' (New York 1896).

TOURAINE, too-rān, a former province and duchy of France, bounded by Maine, Orleannais, Berry, Poitou and Anjou. Its capital was Tours. It now forms the department of Indre-et-Loire. It was anciently inhabited by the Gallic tribe of Turones.

TOURCOING, toor-kwăn, France, a town in the department of the Nord, nine miles northeast of Lille. Before the war it was a well-built and prosperous manufacturing town with modern churches and schools, also a handsome hôtel-de-ville in Renaissance style. It had improved rapidly in a commercial sense, and the staple manufactures are textiles of all kinds, especially woolen goods, velvet carpets and rugs; besides dye-works, soap-works and sugar refineries. The chief imports were wool, flax, yarn and hemp, and the exports combed wool, yarn, tissues, rags and flax. It was captured by the Germans in 1914, and sadly wrecked during the Great War. The population in 1911 was 82,644.

TOURGEE, toor-zhā', **Albion Winegar,** American jurist and author: b. Williamsfield, Ashtabula County, Ohio, 2 May 1838; d. Bordeaux, France, 21 May 1905. He was graduated at the University of Rochester (N. Y.), enlisted May 1861 as a private in the 27th New York volunteers, was wounded at the first battle of Bull Run, and having been discharged, studied law and was admitted to the bar at Painesville, Ohio. In 1862 he re-entered the military service as first lieutenant in the 105th Ohio, in 1864 resigned, and in 1865 began professional practice at Greensboro, N. C. He was a delegate to the Southern Loyalist convention at Philadelphia in 1866, and in 1867 to the constitutional convention of North Carolina, where he drafted the article on the judiciary. From 1868 to 1874 he was judge of the Superior Court of the State. During his term of office the Ku Klux Klan was exposed and largely broken up, and his services to this end were very efficient. The sworn statements of several hundred members received by him were later utilized in a series of fictional works dealing with Reconstruction times in the South, of which 'A Fool's Errand' (1879) was the best known. Contemporary interest in these books was great, and their sales were very large for those days. Tourgee was made consul at Bordeaux in 1897, consul-general at Halifax in 1903, and from then until his death was again consul at Bordeaux. He was editor of *The Continent* (1882–84; 5 vols.), an illustrated weekly published in New York (Vol. III in Philadelphia), and also wrote a few law books. Among his other works were 'Bricks without Straw' (1880); 'John Eax' (1882); 'An Appeal to Cæsar' (1884); 'Button's Inn' (1887); 'With Gauge and Swallow' (1889); 'Murvale Eastman' (1890); 'Out of the Sunset Sea' (1892), and 'The Mortgage on the Hiproof House' (1896).

TOURJEE, Eben, American musical conductor: b. Warwick, R. I., 1 June 1834; d. Boston, Mass., 12 April 1891. He studied at the academy at East Greenwich, R. I., and later opened a small music store in Fall River, Mass. Later he turned to music-teaching, both privately and in the public schools. After a period of study in Europe he opened a conservatory at Providence in 1864. This institution was removed to Boston in 1867 and became the New England Conservatory of Music which has grown to be the most important music institution of the kind in America. In 1872, when the College of Music of Boston University was founded, he became its dean. He was the organizer of several large choruses, notably that assembled for the Peace Jubilee in 1869, and another of nearly 20,000 singers for the World's Peace Jubilee in 1874.

TOURMALINE, a common and wisely distributed mineral, so called from an East Indian name, and known to earlier writers as schorl. It is a very complex aluminum boro-silicate, with several marked varieties depending on the presence and proportions of other metallic oxides. The precise constitution of tourmaline has been recently studied elaborately by eminent mineralogical chemists both in Europe and America, without exact agreement, save in its general features, as derived from a complicated boro-silicic acid. According to the oxides present, three types are clearly determined,— iron tourmalines, mostly black; magnesia tourmalines, usually brown; and alkali tourmalines, in which some lithia is present, of red, green and other rich colors. These last, when transparent, yield beautiful gems, of a hardness of seven to seven and five-tenths and specific gravity three to three and one-tenth. The black variety is quite common in schists, gneisses and granites; the brown is usually in crystalline limestones; the brightly colored varieties occur in dikes of albitic granite, often associated with lepidolite. The gem tourmalines have received a number of special names; the pink or red is called rubellite or Siberian ruby; the green, Brazilian emerald; the deep blue, indicolite, or Brazilian sapphire; the colorless, achroite. The crystals are rhombohedral, hemimorphic and of prismatic habit, either short and stout or long and slender, with three, six, nine or 12 sides, and with rhombohedral, or more rarely, simple basal terminations. The prisms are often so deeply striated vertically as to completely obliterate the faces. The physical properties of tourmaline are very interesting; it is rendered highly electric, both by heating and by friction and it has remarkable polarizing action on light; so that plates cut from transparent crystals, parallel to their length, are much used in experiments in optics, mounted in the so-called tourmaline pincers or tongs. With this is connected a very high dichroism, such that the color is frequently quite different according as light traverses a crystal lengthwise or across. Entirely distinct from this is another peculiar feature, namely, the intermixture of two or more colors in the same crystals, either transversely (concentrically) or lengthwise, sometimes gradually and sometimes sharply; so much so that elegant gems have lately been cut from some of the crystals from Southern California which are half red and half green, with perfectly sharp demarcation between the two brilliant tints. The most noted localities for bright-colored tourmalines are in the Ural Mountains; the island of Elba; Brazil; Paris, Me.; Haddam Neck, Conn., and above all, several mines recently opened in San Diego and Riverside counties, Cal. (See GEMS). Superb black tourmalines occur at Pierrepont, N. Y.; fine brown crystals at Gouverneur, N. Y., and Hamburg, N. J.

TOURNACHON, Felix, French author and aeronaut; b. Paris, 1820; d. there, 1910. He was educated in Lyons, studied medicine but returned to Paris and founded the *Revue Comique* in 1849 and in 1854 published the *Panthéon-Nadar*, both which brought him renown. His experiments in aerial navigation led him to construct a huge baloon, *Le géant*, with which he made several ascensions. At the siege of Paris he was invaluable as a carrier of information and commanded the company of aeronauts. He was the author of a number of publications including 'Les ballons en 1870' (1871) and 'Le Monde où l'on patange' (1883).

TOURNAI, toor-nā, Belgium, a town in the province of Hainault, on the Scheldt, 50 miles southwest of Brussels near the French border, 15 miles east of Lille. It is the seat of a bishop, has pleasant suburbs, fine quays and streets. Its ancient Romanèsque cathedral has five towers and contains pictures by Rubens. Other churches are Saint Quentin, Saint Brice and Saint Jacob, besides the belfry with its wonderful chimes. Other prominent features are a picture-gallery, a library of 60,000 volumes, an episcopal seminary, five hospitals, an asylum, museum of natural history, city hall, theatre and a bronze statue of Princess d'Épinoy, marble bust of Dumortier and many mediæval buildings. The industries embrace the manufacture of woolen goods, hosiery, valuable carpets, linen, ribbon, faience, soap and candles, much of which is handwork. Tournai was in the 5th century the seat of the Merovingian kings, then belonged to France, but later was incorporated in the Spanish Netherlands. It lies near the scene of many battles in 1581, 1667, 1709, 1745, during which years it belonged to France, and in 1914, when it was devastated by the German invasion. Pop. 37,349.

TOURNAMENT, a friendly contest at arms among warriors of noble birth during the Middle Ages. The use of the term was not fixed and it denotes the gathering of the nobles and knights, the contests and the fetes or carousals which followed. A tournament often lasted several days, a week or two, and during this time the lords and knights would gather at the town in which it was to be held, with their servant and esquires, and each would establish quarters which would be made gay with flags and pennants and would erect his arms or insignia. Meantime there would be prepared the lists, the place where the contests were to be held; this consisted of a rectangular space of large dimensions, fenced in by ropes or a railing and surrounded by galleries erected for the ladies and spectators of honor. Certain qualifications of birth were necessary for admission to the contests and each lord or knight had for sponsor some lady whose champion he claimed to be and whose colors he wore. The knights were attended by their squires who furnished them with arms, raised them if dismounted, etc. The weapons used in the contests were lances with the points covered, swords with point and edge dulled and maces or clubs of wood. The knights wore armor which was heavy or light according to the customs of the section in which the contests took place; the latter were held under very exact rules and under the constant supervision of judges and governors. In some of the tourneys it was not allowed the contestant to dismount; he was to run so many courses with the lance or strike so many blows with the sword or mace, and the successful knights received prizes delivered by some lady who had been selected the queen of beauty. On the second day there was often a tourney for the esquires and perhaps on the third day there would be a general melée of knights or squires or even a small mock battle in the lists.

Such were the tournaments of the latter part of the Middle Ages. Their origin is obscure and they seem to have passed through a period in which they were contests in deadly combat and never a friendly contest for skill. It is thought they arose out of the old trials by ordeal (q.v.) and that at first they partook of a judicial nature. Certain it is that at first they were far more deadly than in later years and that they were not uncommonly fought with the weapons of war. Jousts differed from tournaments in two respects: they were single combats between two men and they were oftenest fought with the weapons of war. Jousts were of two kinds — the *joûte à outrance* or mortal combat, usually fought between two representatives of different nations, and the *joûte à plaisance,* the joust of peace which sometimes took place at the end of a tournament, but which seems oftener to have been a prearranged contest in the nature of a duel. Later, while jousts still retained the aspect of a single combat to decide some question of importance, they lost their vicious nature and blood was rarely spilled. The passage of arms was a favorite practice of roving knights, a party of whom would assemble at some place and suspend, each, several shields of different colors, offering combat to any knight who presented himself. The acceptor of the challenge struck the shield of the knight whom he wished to engage and the color and variety of the shield which he struck determined the nature of the combat and the arms to be employed.

The tournament languished with the decline of chivalry, after the 15th century. The death of Henry II, who was accidentally killed in a tilting contest, had much to do with hastening its abolition, but it is probable that the change in the modes of warfare and the critical temper engendered by the revival of learning were more nearly the causes of their abandonment. The word tournament survives in modern contests in chess and checker play, tennis and other games. The contestants are entered, often classified as to their ability and paired off for individual play until every player has met every other player in the tournament. The one with the highest percentage of wins is then declared the victor and receives the first prize. Consult Léon Gauthier's ‹La Chevalerie›; Hallam's ‹Middle Ages› and Viollet-le-Duc's ‹Dictionnaire du Mobilier.›

TOURNIQUET, a contrivance for compressing a blood-vessel to stop the flow of blood in amputations and in dangerous hemorrhage from wounds and to control the circulation through an aneurism. It is believed to have been first used in France by Morel (1674). As used by this surgeon in amputations of limbs, it consisted of a stick passed beneath a bandage and twisted so that the tight knot would exert especial pressure on the principal bleeding vessel, the rest of the bandage compressing the other vessels of the limb sufficiently. At the present time such a tourniquet is known as an emergency tourniquet, which may also consist of anything tied around the part above the wound in case of arterial hemorrhage (below, in case of venous hemorrhage) and twisted by means of a stick or anything convenient. Compression is increased by placing a pad over the main artery. Compression of a bleeding vessel with the thumb or finger is of service where a tourniquet cannot be obtained. Tourniquets are of various kinds and are named principally from their inventors. Du Puytren's tourniquet consists of a semi-circular piece of metal with a head at one end and is used to compress the abdominal aorta; Esmarch's consists of a piece of flat rubber tubing to be wound about the upper part of a limb, after the blood has been driven out of the limb by an elastic bandage or to be used by itself in compression of the iliac arteries, the abdominal aorta, etc. The field tourniquet, resembling Petit's spiral tourniquet, is a padded strap to be buckled on and pressed down by a screw upon an artery. With the horseshoe tourniquet, named from its shape, pressure is exerted at two points. The provisional tourniquet is one applied loosely, to be tightened in case of necessity.

TOURO, too'rō, **Judah,** American philanthropist: b. Newport, R. I., 16 June 1775; d. New Orleans, La., 18 Jan. 1854. He was the son of Rev. Isaac Touro, who in 1762 was chosen rabbi of the Jewish congregation of Newport, R. I. The son removed to Boston, Mass., where he engaged in business with his uncle, Moses Hays, in whose employ he sailed to the Mediterranean in 1798 as supercargo. In 1802 he settled in New Orleans, where he became a wealthy merchant. He displayed his patriotism in the War of 1812 by enlisting as a volunteer in General Jackson's army and was severely wounded at the battle of New Orleans. The range of his benevolence was very broad; families and individuals, churches and synagogues alike were enriched by him. Toward the erection of the Bunker Hill Monument he gave $10,000.

TOURS, toor, **Berthold,** Dutch composer: b. Rotterdam, Holland, 17 Dec. 1838; d. London, 11 March 1897. He studied at Leipzig and Brussels and going to London in 1861 became musical editor to Novello, Ewer and Company, 1878. His productions were principally religious in character and his ‹Service in F,› ‹Blessing, Glory, Wisdom and Thanks› and ‹O Saving Victim,› were especially favorites. As a church composer he represented, with Stainer and Barnby, a new phase of English Church music which comprehends the introduction of new dramatic and melodic elements for which the entire school is probably indebted to M. Gounod.

TOURS, France, capital of the department of Indre-et-Loire, on the left bank of the Loire, at the confluence of the Cher, 130 miles southwest of Paris. The principal entrance to the city is by a magnificent bridge across the Loire, 1,423 feet long. The banks of the river are enclosed by a quay, lined with handsome houses and finely-planted promenades. Great part of the town is new and many of the streets are spacious and elegant; but the older quarters are inferior. The principal edifice is the cathedral. Its west front consists of three lofty-flamboyant portals surmounted by a window of astonishing dimensions and flanked by two domed towers, 205 feet high. The interior, of the purest Gothic, and lighted by beautifully stained glass, is 256 feet in length and 85 feet in height. Two towers form conspicuous objects from every part of the town; one called the tower of Saint Martin or Horloge, from containing the principal clock; the other the tower of Charlemagne, because his queen, Luitgarde, was buried below it, and both remarkable as the only relics which the Revolution of 1793 have left of the vast cathedral of Saint Martin of Tours, after it had flourished for

12 centuries. The archiepiscopal palace is regarded as one of the most handsome in the kingdom. It is the seat of a college, has other excellent educational institutions and a library of 175,000 volumes. The manufactures consist of silk stuffs, ribbons, cloth, serge, rugs, chemicals and leather, besides steel and ironworks and pottery, and the trade is in corn, wine, brandy, dried fruits, wax, hemp, wool, etc. Tours early acquired considerable importance and under the Romans was known by the name of Cæsarodunum. It was from the gates of Tours that Charles Martel (q.v.) drove back the Moslem invasion of Europe in 732. In modern times it became famous for its silk manufactures and had so extended as to have a population of 80,000, when the revocation of the Edict of Nantes deprived it of nearly half its inhabitants and almost all its industry and inflicted a blow on its prosperity from which it has scarcely recovered. During the Franco-German War Tours was made the seat of the government delegation during the siege of Paris, 12 Sept. 1870. The delegation removed to Bordeaux on 10 December. Tours surrendered to the Germans 21 Dec. 1870. Pop. 73,398.

TOURVILLE, toor-vēl, **Anne Hilarion de Cotentin,** COUNT DE, French naval officer: b. Tourville, department of La Manche, 24 Nov. 1642; d. Paris, 28 May 1701. He entered the navy in 1660, became a captain in 1667, participated in the battle of Agosta in 1676, and in command of the vanguard at the battle of Palermo in 1677 he destroyed 12 of the enemy's ships. He was appointed lieutenant-general of marine in 1680, commanded several expeditions against the North African pirates in 1682–88, became vice-admiral in 1689 and in 1690 was in command of the fleet which supported James II of England. He defeated a Dutch-English fleet off the Isle of Wight in that year, but in 1692 was ordered to attack a superior fleet off Cape La Hogue, in order to facilitate the landing of the Jacobites, and was defeated. He was created marshal of France in 1693 and in that year he captured and destroyed a Dutch-English fleet off Cape Saint Vincent. At the outbreak of the War of the Spanish Succession he was appointed commander-in-chief of the combined naval forces of France and Spain, but died shortly after.

TOUSSAINT, Anne Louisa Geertruida, Dutch novelist: b. Alkmaar, 1812; d. 1886. She lived at The Hague after her marriage to the architectural painter, Jan Bosboom, in 1851 and became noted for her novels, especially her historical works. He 'Het huis Lauernesse' (1841; 10th ed., 1885) was translated into several languages and her Leicester trilogy became famous. Her works were collected in 25 volumes. Consult Ten Brink, Jan, 'Life of Anne Louisa Geertruida Toussaint' (Amsterdam 1886).

TOUSSAINT, too-săṅ, **François Dominique,** called L'OUVERTURE, loo-vĕr-tür, Haitian soldier and liberator: b. 1743; d. Fort de Joux, near Besançon, France, 27 April 1803. He was a full-blooded negro and was born a slave. When the insurrection of the blacks broke out in 1791 Toussaint took service in their army, but not till he had assisted his master to escape. He rose quickly in the army, being made in 1795 a general of brigade. In this position he displayed much military as well as political ability and rendered valuable services to the French republic against the British troops which had been landed on the island. In 1797 the French government made him general of division and subsequently general-in-chief of the troops in Santo Domingo, and as such he signed the convention with General Maitland for the evacuation of the island by the British. He now assumed sovereign authority, but it was only after a severe struggle against insurrectionary movements that he was able firmly to establish his position. In 1801, on the submission of the Spanish forts, he was completely master of the island. He now framed a constitution by which he was appointed president for life of the republic of Haiti, with the right to name his successor. He was simple and abstemious in his own habits, but affected great magnificence in his surroundings and exacted a rigorous court etiquette. His character has been highly lauded by Wordsworth in a poem and by Wendell Phillips, who made him the subject of one of his lectures. He ruled with wisdom and justice. Recognizing the failings of most of his own race he chose as his council white men with one exception. By his vigorous government the commerce as well as the agriculture of the island began to revive. After the Peace of Amiens Napoleon sent a powerful expedition under his brother-in-law, Leclerc, to subdue Toussaint, who after a struggle was forced to surrender and on his oath of fidelity was permitted to retire to his estate. He was afterward detected conspiring against the French and being seized by a somewhat unworthy stratagem, was sent to France, where he died in prison. At the time a suspicion of poisoning was general, but there is no evidence to support it. Consult his 'Mémoires' (1853); the lives by Saint-Rémy (1850), Gragnon-Lacoste (1877) and Schœlcher (1889); Mossell, 'Toussaint L'Ouverture, the Hero of Santo Domingo' (Lockport 1896).

TOWAKONI, a sub-tribe of the Wichitas, of the Caddoan linguistic stock of North American Indians, who in 1719 were found on the Cimarron, near its junction with the Arkansas, in the present Creek Nation, Indian Territory. Later they were on the Brazos and Trinity rivers of Texas and in 1822 were reported to number 1,200. They made their first treaty with the United States in 1837. In 1840 they were said to have numbered 500 and to have resided on the Pecan branch of the Colorado River of Texas, but by 1850 their population was reported at 140 and their home on the Upper Brazos. They are now with the Wichitas on a reservation in Oklahoma, where they number about 130.

TOWANDA, tō-wän'da, Pa., borough, county-seat of Bradford County, on the Susquehanna River and on the Lehigh Valley Railroad, about 50 miles north by west of Scranton. It is in an agricultural and stock-raising region and is the commercial and industrial centre for a large portion of the country. The chief industrial establishments are planing-mills, furniture factories, wagon and carriage works, a large toy factory, a piano factory, foundries and machine shops. The water supply comes from springs 16 miles from the borough. The educational institutions are Susquehanna Collegiate Institute (Presbyterian), founded in 1850, a high school, public and parish schools, a high school library containing about 5,000 volumes and a college library. The two national banks have a combined capital of over $300,000. Pop. 5,000.

TOWER, Charlemagne, American diplomatist: b. Philadelphia, 17 April 1848. He was graduated at Harvard in 1872 and spent four years in study and travel in Europe and the East, part of which time he was attaché to the American legation at Madrid under Daniel E. Sickles, Minister to Spain. After his return he was admitted to the bar in 1878 and in 1882 removed to Duluth, Minn., where he was connected with large railroad and mining interests. In 1887 he settled in Philadelphia and in 1891 relinquished active business affairs and gave his attention to historical studies. He became president of the department of archæology and palæontology at the University of Pennsylvania. In 1897 he was appointed United States Minister to Austria-Hungary; during 1899–1902 he was Ambassador to Russia, and in the latter year became Ambassador to Germany, retiring in 1908. He published a ‹Catalogue of a Collection of American Colonial Laws› (1890); ‹The Marquis de Lafayette in the American Revolution› (1895); ‹Essays Political and Historical› (1914).

TOWER, Zealous Bates, American soldier: b. Cohasset, Mass., 12 Jan. 1819; d. there, 21 March 1900. He was graduated from West Point in 1841 and was appointed second lieutenant of engineers the same year. He was employed in the construction of the defenses of Hampton Roads in 1843–46 and served with distinction in the Mexican War. Promoted major in August 1861, he fought in the first battle of Bull Run and for bravery in the second battle of Bull Run was brevetted major-general. He became lieutenant-colonel in 1865 and colonel in 1874, and was retired in 1883.

TOWER, *in architecture,* a structure more or less lofty, of varied form or plan, whether standing alone or forming a part of a church, castle or other building, but essentially high as regards its surroundings. In ancient times towers were erected as memorials to the dead, for purposes of defense and as religious monuments. Mediæval castles usually had one or more towers, serving for observation and also adding to the sightliness of the structure. The walls of ancient fortifications usually bore towers at intervals for commanding the vicinity, from which defenders might more easily shoot arrows at besiegers. When a tower is very long and slender it is termed a spire, as on many churches. Numerous little towers on a structure are named turrets. In old stone structures, as the Tower of London, the towers were apt to be circular. As Gothic architecture developed, square and rectangular towers were more common. In Oriental architecture there is a tendency to finish a tower with a dome. In modern structures towers are mainly for ornament and are located at one or all the four corners of a building, or centrally. Among towers are included the mosques of the Mohammedans, the lofty bell towers common in Russia, ancient lighthouses along the seacoasts and the round towers (q.v.) of India, Ireland and other countries. The tower bastion of mediæval castles contained rooms and cells. (See BASTION). Water towers are similar to stand pipes (q.v.). See GABLE for a description of gabled towers; also CAMPANILE; EIFFEL TOWER; PISA; MONUMENTS; PAGODA; TOPE.

TOWER, Round, a building peculiar to early Christian architecture, of slender form and usually bearing a conical roof. Windows are few in number and generally small. The type is common to Ireland, and in addition to the Irish bee-hive huts forms its only distinctive contribution to architecture (see IRELAND, *Architecture*). More than 100 exist in Ireland. A few examples are to be found in Great Britain and on the Continent, pointing to the time of the invasion of the Irish missionaries. The smallness of the windows seems to make it improbable that the towers were used for bells and rather points to their employment for defensive purposes. The name is given to remains of structures of American Indians of the Pueblo type. They are found standing in isolation or in connection with walls of rectangular form. They are built of roughly-dressed stone and some are interesting structurally for their two or three concentric walls, with the two outer ones connected by transverse walls on radial lines. See IRISH ARCHÆOLOGICAL REMAINS; IRISH ART.

TOWER BRIDGE, London. See BRIDGE; paragraph *Movable Bridges;* also LONDON.

TOWER CLOCKS. See CLOCKS.

TOWER OF LONDON. See LONDON.

TOWER MUSIC. See CHIMES.

TOWER OF SILENCE. This name is applied to structures built by the Parsees for the disposal of their dead. They are towers — called dakhmas — about 40 feet high and with large diameter. Somewhat below the top of the wall is built a floor of iron grating and upon this the bodies of the dead are placed until by exposure to the elements and to birds of prey the flesh is entirely removed from the bones and they have fallen into a pit below. There are evidences that they were carefully chained. One of these «towers of silence» stands in the neighborhood of Bombay, India. It is believed that their primary purpose was sanitary, to prevent contamination of local soil and water.

TOWER OF THE WINDS. See ATHENS.

TOWHEE BUNTING, a large, black, white and chestnut bunting of the American genus *Pipilo,* several species of which occur in the United States. Several are confined to the southwest, but one species, the chewink, or ground-robin (*P. crythropthalmus*) is numerous in summer throughout the whole of the eastern half of the country, and its sharp, metallic call is familiar to every countryman. In spring the male has a delightful song, but one not frequently heard. The nest of the towhee is made upon the ground in the woods, where the birds spend most of their time, scratching vigorously among the leaves for their food, and its five red-spotted eggs are cleverly concealed by a domed canopy of twigs and leaves. Consult Wilson, Audubon and other writers on American birds.

TOWN, Ithiel, American architect: b. Thompson, Conn., 1784; d. New Haven, Conn., 13 June 1844. With Alexander J. Davis he designed the old Capitol (since razed) at New Haven, the city hall at Hartford and the State capitols at Indiana and North Carolina. Town also designed churches at Hartford and New Haven and a bridge at Richmond, Va., over the James River. He is the author of a number of books on architectural and other subjects. His large library went in part to Yale College. He was one of the original members of the Academy of Design.

TOWN GOVERNMENT. See MUNICIPAL GOVERNMENT; TOWN AND TOWN MEETINGS.

TOWN AND TOWN MEETINGS. In its broadest meaning the word town denotes simply a collection of houses without regard to the size of the collection and without regard to the form of its political organization. In this sense a hamlet without any governmental powers at all of its own may be referred to as a town and likewise a great municipality like New York or London may be thus designated. In some of the Southern and Western States «town» is the legal designation of a municipal corporation whose powers are greater than those of a village and smaller than those of a city. In the New England States, while the word town is often used in a loose or broad sense, more frequently a town denotes a minor civil division (elsewhere called township) which is sometimes wholly rural, sometimes wholly urban and sometimes partly rural and partly urban. An advertised meeting of the voters of a New England town summoned for the consideration of local business is called a town meeting.

The Pilgrim Fathers who settled at Plymouth (1620) and the Puritans who settled (1628–30) at Salem and Boston began at once to develop a system of local government. They settled in compact communities and gave the name town to the thickly inhabited portion of a grant or purchase. The organization of the town was accomplished through the agency of a town meeting. The early settlers of New England were equals in social rank; their average of intelligence was high; they were nearly equal in worldly possessions. Respecting matters of government, they were intensely democratic and at the same time intensely theocratic. They believed that the state should be a «city of God» and that authority in spiritual and temporal matters should flow from a common source. Accordingly their town meetings were religious assemblages acting as pure democracies, except in Rhode Island, where the civil authority did not interfere in matters of conscience. The meetings in colonies where the theocratic principle prevailed were usually held in a church, and all the male church members of the town who were of legal age could attend and take part in the discussions and vote upon any question that might arise. The town was incorporated and its boundaries were defined by the colonial legislature. It was then left to govern itself pretty much in its own way, providing, of course, it did nothing contrary to the laws of the colony. At first, while local government was getting under way, town meetings were called every month or two. In Boston in 1635 10 general town meetings were held. The people soon found, however, that they could not give so much time to public affairs and it was not long before it became the custom to summon the town meeting but once in the year, provision being made for calling special meetings when there was need. The town meetings elected such officers as were required for the management of local business and made such by-laws (town laws) as commended themselves to the judgment of the community. For the management of the affairs of the town during the interval between town meetings a board of townsmen, usually called selectmen, was elected. The number of selectmen in the earlier towns ranged from 3 to 13. These officers administered the finances of the town, appointed sundry subordinate officials, let out contracts for public work and exercised such powers as were necessary to secure and maintain the peace, safety, comfort and religious conformity of the people. As stewards of the people they gave to the town meeting an account of their stewardship in the form of an annual report. A town clerk, who acted as secretary of the meeting and who served as the recording officer of the town, and a constable, whose duties, broadly speaking, were those of a peace officer, were always chosen. The selectmen, the clerk and the constable were the constitutive officers; no town was without them. Among other officers elected in the early town meetings may be mentioned the tithingman, a kind of Sunday constable, who saw that the people came to church and with fox-tail wand kept them awake during the sermon; the fence-viewer, who supervised the erection of boundary fences between adjoining owners; the hog-reeve, who saw that rings were kept in the noses of swine running at large; the field-driver, who impounded stray cattle. Representatives to the colonial legislature were also elected in town meeting. Besides electing town officers, the town meeting acted as a legislature for all matters of local concern. It levied the town taxes; it passed by-laws relating to the use of common fields and pastures; it made assignments of lands to individuals; it provided for the management and support of the schools. In all New England colonies but Rhode Island it regulated and controlled all affairs connected with the church, subject to the superior authority of the colonial legislature. No detail of the civil or religious life of the community was too small for the attention of the town meeting. It prescribed the manner in which the schoolmaster should use the rod; it directed the arrangement of seats in the church; it specified the hour of the day at which the woodman should begin to wield his axe.

Such was the early New England town meeting. Its origin is traced by some students of political science to the Anglo-Saxon *tunscipe* and to the still earlier Teutonic mark. The early New England town certainly bore a strong resemblance to the ancient type of Teutonic local government. The name town itself reminds us of the Saxon tun (Old German *Zun*, a hedge); the selectman reminds us of the Saxon *gerefa*, headman (he was actually called «headman» in Rhode Island); the town meeting was, in many particulars, a counterpart of the Saxon Tunmoot. There is no evidence, however, that the New England settlers consciously imitated any existing or pre-existing type of local government when they developed their town system. They brought to their task English political instincts and English traditions and availed themselves of English experience, but the town as an institution, both in its organization and in its functions, was an outgrowth of the peculiar social, economic and political conditions which prevailed in New England during the first years of the colonial period.

The town meeting system described above had its beginnings in the settlements of Plymouth, Salem and Boston and was adopted by the offshoots of these parent towns. Whenever the population of a grant or purchase became sufficiently large to support a church and conduct local government it was incorporated by the central legislative body and a town meeting was called. Thus the town system grew as New England grew, and was soon deeply rooted in the affections of the people. It resulted in a society that was as purely democratic as any the world had ever seen. During the colonial period the town was the distinguishing feature of New England life, and when the Revolution came the little democracies proved to be powerful aids in the cause of liberty. In the town meeting it could easily be learned who were loyal and who were not. Through the agency of the town organization military stores were secured and the famous minutemen (q.v.) were organized. The resolutions of numerous town meetings voiced in the plainest manner possible the sentiment for independence and were the precursors of the Declaration itself. And their influence in great public affairs continued after the Revolution. «How powerfully,» said Thomas Jefferson, «did we feel the energy of this organization [the town] in the case of the Embargo (q.v.). I felt the foundations of government shaken under my feet by the New England townships. There was not an individual in their States whose body was now thrown with all its momentum into action, and although the whole of the other States was known to be in favor of the measure, yet the organization of this selfish community enabled it to overrule the Union.» In another place the great Democrat says: «They [New England towns] have proved themselves the wisest invention ever devised by the wit of man for the perfect exercise of self-government and for its preservation.»

In its essential characteristics town government in New England has not changed greatly since the days of the early settlers, except in its religious feature; that feature entirely disappeared in the early part of the 19th century, when the separation of Church and State was achieved. Details in the organization and in the powers of the town differ in the different New England States, yet the outlines of town government in all these States are practically identical and are as follows: The State legislature defines the boundaries of the town, incorporates it, and confers powers upon it. As a corporation, the town can sue and be sued, and can acquire and hold real property. A town may be divided by the legislature into two or more towns or can be united with and made a part of another town. The public affairs of the town are transacted in a town meeting which meets annually, and also assembles in special meetings which may be called from time to time. The meeting is held in the town hall or in some other hall sufficiently large to accommodate the mass of voters. When the people have assembled, the town clerk calls them to order and states the purposes for which the meeting is called. A moderator (presiding officer) is then chosen and business proceeds according to parliamentary rules. All questions are decided by a majority vote of the legally qualified voters in attendance. Usually citizens who are qualified to vote for a governor and for members of the State legislature are also qualified to vote in town meeting. Here is democracy in its purest form. Young and old, rich and poor, the obscure and the prominent, are present, and every citizen may not only vote, but, if he chooses to do so, may also bring the full force of his character and influence to bear upon the deliberations of the meetings. Routine business is quickly disposed of, but those matters which happen to be the subject of contention are generally discussed fully and freely. The right to vote on local taxation and appropriations is in some States reserved to taxpayers. The finances of the town are watched keenly, and if there has been mismanagement or extravagance during the past year there is sure to be a merciless exposure in the town meeting. If improvements are needed or if the town is lagging behind its neighbors in progressiveness, the discussion in the folkmoot is likely to be directed toward a remedy. At annual town meetings the following things are done: (1) The rate of taxation for the coming year is fixed. Money is appropriated for the schools, for the care of the roads, for the support of the poor, for the salaries of officers and for other necessary expenses. Sometimes the schools are managed by school districts. When this is the case each district elects its own officers and sometimes also makes its own levy, but the town meeting or town council elects the school superintendent. (2) By-laws are passed. These may relate to such matters as infectious diseases, locations of sidewalks and curbstones, the erection of buildings, the regulation of the speed of vehicles. Many things which in other places are done by a body of chosen representatives are done in town meeting by the people themselves acting as legislators. (3) Town officers are elected. At the head of these stand the selectmen, or councilmen, three or five or seven in number. These are the executive officers of the town. They supervise the construction of roads, grant licenses, care for the poor, abate nuisances, check the spread of contagious diseases, listen to the complaints of those who have grievances of a public nature, select jurymen, canvass the voting list, look after the paupers and represent the town in court when it is sued. When a specified number of voters sign a call for a special town meeting it is the duty of the selectmen to place on the town post a warrant which calls the meeting and states the purposes for which it is called. After the selectmen, the town clerk is next in importance and usefulness. This officer calls the town meetings to order and keeps a record of its proceedings. In addition, he usually keeps a record of the births, marriages and deaths and grants certificates of marriages and the real estate records of the town. Town assessors make out a list of the taxpayers of the town and place an estimate upon the value of their property. Sometimes the selectmen themselves act as assssors. In addition to the officers mentioned the town meeting usually elects tax collectors, a town treasurer, town solicitor, overseers of the poor, a school committee, trustees of the town library, constables (peace officers), surveyors of highways, fence-viewers, milk inspectors and field-drivers, or it refers the election of these officials to the town council. All town officers have a tenure of one year. The list of officers which has been given is not complete, yet it is long enough to show that in every New England community a great many people must take a part in public affairs. Undoubtedly it is this general participation in the business of government that makes the people of this part of our Union such a wide-awake and progressive body of citizens.

In all the New England States (Massachusetts excepted) the town is the unit for representation in at least the lower branches of the State legislature. Government in New England is, therefore, by towns rather than by counties, as in other States. The town has so many functions and absorbs so much local business that little is left for the county to do. Indeed the county in New England exists principally for judicial purposes; in Rhode Island it exists solely for judicial purposes. As it is to-day so it has always been: throughout the whole period of her history the focus of New England life has been the town. «Towns,» says Joel Parke, «have been the arterial system of New England through which has circulated the life-blood which has invigorated, sustained and strengthened her, making her expand in her religious, social, educational, benevolent and political institutions.» The people cling tenaciously to their town system. Boston did not change from town to city government until 1820 when, with a voting population of 7,000, she found that the town meeting could no longer act as a deliberative body. Yet the conditions of population in recent years sometimes make it extremely difficult to administer local government on the town plan. People are moving from the country to the city, depleting some towns and making others too large to meet in mass. Towns in New England vary in population from less than 100 souls to 20,000. As a matter of experience local government in New England is changing with the new conditions. So long as the population of a place remains below 10,000 (the population of Aristotle's ideal city) town government is usually economical, efficient and pure, but when the population greatly exceeds that number the interest of the citizens in local matters begins to flag, the town meeting becomes unmanageable and the town government is in danger of falling into unworthy hands. The remedy is municipal incorporation. The thickly inhabited part of the town secures a charter and becomes a borough or village or city and the people surrender a part of the public business to chosen agents. This change, however, usually does not extinguish town government within the boundaries of the new municipality, although it does take from it many of its former powers.

While town government in its pure form is found only in New England, modifications of it appear in those Western States whose population contains a strong admixture of New England emigrants, notably in Michigan, Illinois, Wisconsin, Minnesota and Nebraska. Each of these States has provided by law for a system of local government which resembles more or less closely the New England system. In Michigan, for example, the voters of a township, after they have elected their local officers, meet in the afternoon in mass for the transaction of certain local business. At this meeting they may regulate the keeping and sale of gunpowder, the licensing of dogs, the vaccination of the inhabitants; they may order the purchase of books for the town library; they may under certain restrictions, and within certain limits, order the raising of money by taxation. In Illinois, in those towns which have adopted the township system, there is a similar meeting of the voters after the township officials have been elected. Here we have the form at least of the town meeting, but it does not appear that the spirit of the New England town vivifies these western meetings. Township government in the West has always been and continues to be essentially representative. A New England town meeting may last for a day, sometimes for two days, and personal attendance for so long a time means inconvenience and money loss. Representative government, on the other hand, requires no such sacrifice. Because town government requires so much of the citizen's time and burdens him with such great responsibility, it has been extremely difficult to transplant it. The example of the town meeting has undoubtedly had great influence upon the course of local government in all parts of the Union, but it cannot be said that town government, either in spirit or in form, is vigorous in any State outside of New England.

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S. E. Forman,
Author 'First Lessons in Civics.'

TOWNE, Henry Robinson, American manufacturer: b. Philadelphia, Pa., 28 Aug. 1844. He attended the University of Pennsylvania but left school to become a draftsman in the Port Richmond Iron Works. In 1863 he was placed in charge of government work in the shops and later, in 1864, was in charge of building the engines for monitors and similar important work until the close of the war. In the course of time he took a special course in physics at the Sorbonne, Paris, and in 1866 he became associated with Linus Yale in making his famous locks, and after the latter's death was president of the corporation until 1915. Later he became chairman of the Federal Reserve Bank of New York and was connected with other business interests. He is the author of 'Towne on Cranes' (1883) and numerous technical papers.

TOWNE SCIENTIFIC SCHOOL, a department of the University of Pennsylvania. See PENNSYLVANIA, UNIVERSITY OF.

TOWNELEY, Charles, English art collector: b. Burnley, Lancashire, 1737; d. London, 1805. He was educated at Douai College and began collecting art objects abroad in 1768. He made frequent trips abroad for the purpose and in 1791 was made a trustee of the British Museum. His collection of marbles, known as "The Towneley Marbles," together with his statuary, medals and other gems of ancient art, was bought by the museum after his death. Consult Ellis, 'The Towneley Gallery' (London 1846).

TOWNELEY MARBLES, a notable collection of Greek and Roman sculpture, forming a portion of the gallery of antiquities in the British Museum; so named after Charles Towneley, by whom the collection was made.

TOWNSEND, Charles Elroy, American politician: b. Concord, Mich., 15 Aug. 1856. He was educated at the Jackson High School and at the University of Michigan, and was admitted to the bar in 1895. He was a delegate to the Republican National Convention in 1888 and served on the State Central Committee (1898–1902). In 1903–11 he was elected a member of Congress from the second Michigan district, and on 18 Jan. 1911 was chosen United States Senator.

TOWNSEND, Charles Haskins, American zoologist: b. Parnassus, Pa., 29 Sept. 1859. He was educated at public and private schools and became assistant United States Fish Commissioner in charge of salmon propagation in California in 1883. He remained in the government service in various positions until 1902, when he was made director of the New York Aquarium, a position which he still holds. He is author of numerous monographs relating to fisheries, fish culture, etc.

TOWNSEND, Edward David, American soldier: b. Boston, Mass., 22 Aug. 1817; d. Washington, D. C., 11 May 1903. He was graduated from West Point in 1837, served in Florida 1837–38 and on the Canadian frontier in 1838–41; was promoted captain in 1848 and colonel in 1861. In the year last named he was made chief of staff to Lieut.-Gen. Winfield Scott. In March 1865 he was brevetted major-general United States army, and was placed on the retired list in 1880. He published 'Catechism of the Bible — The Pentateuch' (1859); 'Catechism of the Bible — Judges and Kings' (1862); 'Anecdotes of the Civil War in the United States' (1884).

TOWNSEND, Edward Waterman, American author: b. Cleveland, Ohio, 10 Feb. 1855. He was for some years on the staff of the New York *Sun* and in 1895 became widely known by his 'Chimmie Fadden and Major Max,' in which a typical New York boy of the rougher class is depicted. Later works include 'Chimmie Fadden Explains, Major Max Expounds' (1895); 'A Daughter of the Tenements' (1896); 'Lees and Leaven' (1903); 'Reuben Larkmead' (1905); 'Our Constitution' (1906); 'Beaver Creek Farm' (1907); 'The Climbing Courvatells' (1909).

TOWNSEND, George Alfred, American journalist: b. Georgetown, Del., 30 Jan. 1841; d. 15 April 1914. He was graduated at the Philadelphia High School in 1860 and entered journalism. He was special war correspondent of the New York *Herald* and *World* in 1861–65, afterward engaged as a lecturer, and in 1866–67 he was in Europe as special correspondent in the Austro-Prussian War and later at the Paris Exposition. For many years after 1868 he was an editorial writer and correspondent on the staff of the Chicago *Tribune,* and his contributions to the press, under the penname "Gath," have been widely read. His publications include 'Campaigns of a Non-Combatant' (1865); 'The Real Life of Abraham Lincoln' (1867); 'Washington Outside and Inside' (1871); 'Tales of the Chesapeake' (1880); 'The Entailed Hat' (1884); 'President Cromwell' (1885); 'Mrs. Reynolds and Hamilton' (1890); 'Columbus in Love' (1892); 'Poems of Men and Events' (1899); 'Poems of the Delaware Peninsula,' etc.

TOWNSEND, Lawrence, American diplomat: b. Philadelphia, 13 Aug. 1860. He was educated at the University of Pennsylvania and spent some six years in Europe in the study of international law and the history of diplomacy. He was first secretary of the American legation at Vienna 1893–97, Minister to Portugal 1897–99 and Minister to Belgium, 1899–1905.

TOWNSEND, Luther Tracy, American Methodist clergyman: b. Orono, Me., 27 Sept. 1838. He was graduated from Dartmouth in 1859 and from Andover Theological Seminary in 1862, served in the Federal army during a portion of the Civil War, and in 1864 entered the Methodist ministry. He was professor of Hebrew in Boston University 1868–70 and of practical theology there 1872–93. He has since been professor emeritus. He has published among many other works 'Credo' (1869); 'Bible Theology and Modern Thought' (1883); 'Evolution of Creation' (1899); 'God's Goodness and Severity' (1903); 'God and the Nation' (1905); 'Doctrine of the Trinity' (1910); 'Bible Studies' (1913); 'God and War' (1915); 'Hell Is No Myth' (1917).

TOWNSEND, Thomas Seaman, American compiler: b. New York City, 27 Aug. 1829; d. there, 1908. He was given a classical education but devoted himself to commercial life. His renown rests chiefly on a compilation of newspaper clippings relating to the Civil War which fills 125 large volumes and forms a mine of information for the historian of the times from 1860 to 1901. The collection is in Columbia University Library and is entitled the 'Townsend Library of National, State and Individual Civil War Records.' He also lectured and gave addresses on the War of the Rebellion.

TOWNSHEND, town'zĕnd, **Charles, 2D** VISCOUNT, English statesman: b. Rainham, Norfolk, 10 March 1674; d. there, 21 June 1738. On the death of his father, the first viscount, in 1687, he succeeded to the peerage and took his seat as a Whig in the House of Lords, 1695. He was one of the commissioners for arranging the Scotch Union (1706), was joint plenipotentiary with Marlborough in the conference at Gertruydenburg (1709), and as Ambassador to the States-General signed the Barrier Treaty at The Hague, 29 Oct. 1709. He was censured by the House of Commons for this action and declared an enemy of the queen and kingdom. He accordingly entered into correspondence with the elector of Hanover, who, on his accession as George I, appointed Townshend Secretary of State, 1714. In 1717 he was made lord-lieutenant of Ireland; was again Secretary of State from 1721 to 1730, when he retired by reason of disputes with his brother-in-law and colleague, Sir Robert Walpole.

TOWNSHEND, Charles, English statesman: b. 29 Aug. 1725; d. London, 4 Sept. 1767. He was grandson of the 2d viscount Townshend, was educated at Leyden (probably also at Oxford) and entered Parliament in 1747. The next year he received a minor office and in 1754 became Lord of the Admiralty. From this post he rapidly advanced and became a member of the Privy Council in 1757, Secretary at War in 1761, and in 1766 Chancellor of the Exchequer. Pitt's entrance into the House of Lords and eventual incapacity through ill health left Townshend virtually at the head of the government, and he defied his nominal chief in declaring the right of the East India Company to territorial revenue and made use of his official position to secure for himself a large share in a public loan. In 1767 he was defeated on his proposition for a land tax. On 13 May he introduced measures dealing with the American colonies, virtually reviving the principles of the Stamp Act, which had lately been repealed. The American Revolution was caused by the imposition of taxes which he proposed. His reputation as an orator was scarcely second to that of Pitt himself. Of his qualities Lecky has written: «Exuberant animal spirits, a brilliant and ever ready wit, boundless facility of repartee, a clear, rapid and spontaneous eloquence, a gift of mimicry which is said to have been not inferior to that of Garrick and Foote, great charm of manner, and an unrivaled skill in adapting himself to the moods and tempers of those who were about him, had made him the delight of every circle in which he moved, the spoilt child of the House of Commons.» Consult Cobbett, ‹Parliamentary History of England to 1803› (1806–20); Fitzgerald, ‹Charles Townshend, Wit and Statesman› (1866).

TOWNSHEND, Sir Charles James, Canadian jurist: b. Amherst, Nova Scotia, 22 March 1844. He was educated at King's College and became a noted barrister. He was at one time a member of the law faculty at King's College and practised successfully at Amherst, was a puisne judge (1887), and since 2 Nov. 1897 has been chief justice of Nova Scotia. He was knighted by King George in 1911. He was conservative member of the House of Commons (1884–87) and held other positions of honor. Among other papers he is the author of ‹A History of the Courts of Judicature in the Province of Nova Scotia.›

TOWNSHEND, Charles Vere Ferrers, British soldier: b. 1861. He joined the army from the Royal Marines in 1886 and was a major-general in 1911. His life was one of constant activity and in the Great War he commanded the Mesopotamia campaign until compelled to surrender at Kut-el-Amara for lack of food after a five months' siege by the Turks. Previously he had served in the Sudan and Nile expeditions (1884–85), participated in the South African War (1899–1900) and was with the British army in India (1907–09).

TOWNSHIP, a local minor civil or political division of territory within a county in the United States, outside of New England where they are termed towns. See TOWN AND TOWN MEETINGS.

TOWNSLEY, Clarence Page, American army officer: b. De Kalb, N. Y., 24 Sept. 1855. He was educated at the Potsdam Normal School, Union College (1876) and the United States Military Academy (1881). He also attended the Government Artillery and Torpedo schools and was active in various positions, reaching the superintendency of the United States Military Academy at West Point (1912–16) and being appointed commander of the 30th division, National Guard, in 1917.

TOWNSVILLE, Australia, the most important town of northern Queensland, Australia, situated on Cleveland Bay on the east coast. It has a number of fine buildings, including a new cathedral, a new custom-house, the Supreme Court building and a large prison. The chief industrial establishments are an iron foundry, an ice plant, a soap factory and meat packing houses. The town has a good harbor, well fortified; it is the terminus of a railroad to Hughenden and the chief outlet for the products of northern Queensland. The great Commonwealth Bank has a branch here. The exports amount to nearly $15,000,000 annually. Pop. 13,835.

TOWSE, John Ranken, American dramatic critic: b. Streatham, England, 2 April 1845. He was educated at Cambridge University and came to New York in 1869. He took up newspaper work and since 1874 has been dramatic critic of the *Evening Post.* He published ‹Sixty Years in the Theatre: an Old Critic's Memories› (1913–16).

TOXICOLOGY, the study of poisons. The word poison is difficult to define, since many substances which in minute amounts exercise no harmful action on the body may in large quantities produce disastrous effects. Then again, some substances which are harmless when taken into the stomach, as water, for instance, if injected into a blood-vessel prove very dangerous, causing death at times from the destructive action of the water on the blood-cells. Moreover, the many studies of recent years on bacteria and other low forms of life have resulted in a new series of conceptions regarding the poisonous actions of the compounds formed by these bodies; and still further, certain forms of perverted metabolism of the human body result in the production of certain products which, retained by the body, work harmful effects. (See AUTO-INTOXICATION; METABOLISM). If all the different factors are taken into consideration, a strictly scientific definition of the word poison cannot be given. In general it is said that a poison is any substance which brings about a change in the molecular composition of an organ or organs, causing its functions to depart very distinctly from the normal. But what grade of molecular disturbance is necessary to make a substance a poison, or how far from the normal must be the functional alteration, it is impossible to say. Many substances, strychnine for example, while being distinctly poisonous in appreciable doses, are very useful and helpful to the body when given in small amounts. Infinitesimal doses of copper salts act as pronounced poisons on certain forms of lowly organized plants, while a higher plant, the potato, does not suffer from large doses used as a spray to kill insect or fungus-parasites.

The modern conception of poisonous action is essentially a physico-chemical one, the distinction between a molecular physical action and a molecular chemical action being difficult to make. But it is believed that for practically all forms of poisons a distinct alteration in the character of the cells of the body takes place, as well as a change in the chemical composition of the poisonous substance. It is impossible at the present time to summarize these changes. It is rarely that the reaction between the body-cell and the poison is purely of a physical nature, yet this very frequently happens in many poisons that act on the blood. By some of the poisons — the anilines, for example — the blood undergoes changes, not so much due to new chemical compounds formed, as to physical changes in the tension of the blood-serum and the blood-corpuscles, whereby the blood-coloring matters stream out into the plasma, and the oxygen-carrying function of the blood is lost. Similar types of poisoning result from some of the metals, and the poison of the cholera organism is thought to act in a like manner. In other poisons there is a direct union of the ions of the poison with some constituents in the cells of the body, making new chemical compounds, and thus interfering with the molecular activities of the cells.

Von Jaksch has divided the poisons into two classes: the exogenous poisons, or those that come from without the body, and enter by way of the skin, the lungs, the stomach or the intestines; and the endogenous intoxications that result from changes within the human body through disordered metabolism. Occasionally the former class may cause such changes in the body that death results from an intoxication of the second variety. Thus a severe irritant to the kidneys, such as cantharides, may cause such an acute inflammation of that organ that it cannot secrete urine, and the patient may die of uræmic poisoning. In much the same manner certain bacteria find entrance into the body and develop poisons both within the tissues and also in the intestinal canal, and furthermore provoke putrefactive processes in the food in the intestinal canal. This brings about a triple form of poisoning, as it were.

The different types of poisoning are many. They cannot all be given in the space here available, but the symptoms and general treatment of a few of the more common types of poisoning will be mentioned. Poisoning by the mineral acids, nitric, sulphuric, hydrochloric, is not uncommon. In these there is a marked caustic action, with intense burning pain when taken by the mouth. The lips are stained yellow, black or white respectively, according to the acid taken. There is nausea, vomiting and diarrhœa, with all the symptoms of an intense gastro-enteritis, with collapse, pale face, cold sweating extremities, small, feeble pulse, rapid respiration; and the patient dies in intense agony. Treatment is by prompt washing out of the stomach with an alkaline solution, soap, washing soda or other mild alkali being useful. Then comes the use of heat, of mucilaginous drinks, such as white of egg, gum arabic, slippery elm, olive oil, milk, etc. The technical details require prompt medical attendance as soon as the washing out with the alkaline solution is commenced.

Oxalic acid is frequently swallowed by mistake. Here the staining is usually absent; the gastro-enteritis is marked as in poisoning with the mineral acids; there is great muscular weakness and twitching of the muscles, particularly about the face; sometimes there are convulsions and further symptoms of collapse are present. In treatment wash out stomach by tube, or by drinking large quantities of water with lime — teaspoonful of lime to quart of water — and stimulants. Following oxalic poisoning large quantities of water should be taken for a week or so to flush the surplus oxalates from the kidneys.

Poisoning by alkalis is infrequent. Occasionally sodium hydrate, or potassium hydrate, is swallowed. Lime is also taken by accident; so (rarely) is ammonia. The symptoms are much like those of poisoning by the mineral acids. There are no marked discolorations, as noted, but otherwise the symptoms are similar. Treatment is by rapid washing of stomach with weak acids, vinegar being the most convenient, and by demulcents, as in acid-poisoning.

The halogen compounds are very markedly poisonous as gases, notably chlorine, bromine, fluorine; and the iodides and bromides cause forms of chronic poisoning known as iodism and bromism (q.v.).

The heavy metals as such are not poisonous, but their soluble compounds are all poisonous. They vary widely, however, in strength. In order, from the strongest to the weakest, they are caustic or astringent; severe caustic metallic salts being, in order, mecury, tin, silver, antimony, copper, zinc, iron and aluminium. But in poisoning the acid part of the salt is of importance. From strongest to weakest these acids run: hydrochloric, nitric, sulphuric, phosphoric, acetic, citric, tartaric. If a caustic metal is combined with a caustic acid the resulting salt, if soluble, is a very powerful poison, mercuric chloride, or corrosive sublimate, being an illustration. If a weak metal like iron is combined with a strong acid the result is an intermediate poison like chloride of iron; when a weak metal, as lead, is combined with a weak acid, as acetic, lead acetate, sugar of lead, a weak poison, is formed. Thus the strength of a metallic salt may be calculated from the comparative positions of the metallic and acid ions. In all these metallic poisons albumen compounds are formed. The coagulum varies in all and according to its solubility or insolubility the burning of the poison is more or less deep. In all the symptoms are analogous; there is severe gastro-enteritis, with symptoms of collapse. The treatment is similar in all: washing of the stomach, white of eggs, milk, demulcents, artificial heat, respiration and afterward careful feeding.

Arsenic and phosphorus are poisons that

give very similar symptoms: acute gastro-enteritis, with nausea, vomiting, purging; then some grade of apparent recovery, to be followed after a few days with a recrudescence of the gastro-enteritis and the development of secondary blood-vessel changes, which may cause minute hemorrhages in any part of the body. Then follow fatty degeneration and death. The commonest form of salt causing arsenic-poisoning is Paris green; while rat-poison and matches are responsible for most cases of phosphorus poisoning. Treatment of arsenic poisoning calls for prompt washing of the stomach, small doses of magnesia and water every 15 minutes for several hours and stimulant supportives. Phosphorus can usually be detected by the odor. There should be prompt washing, and avoidance of oils, although castor-oil may help in getting phosphorus out of the intestinal canal. Authorities, however, prefer the saline cathartics. A prompt oxidizing agent, permanganate of potash or hydrogen peroxide, should be used, or small doses (1 to 2 grains), diluted, of copper sulphate.

For the effects of poisoning by the alcohols, see ALCOHOLISM. Practically all of the anæsthetics (ether, chloroform, ethyl chloride, etc.) and hypnotics (chloral, paraldehyde, trional, sulphonal, veronal, etc.) belong to the alcohol group (see ALCOHOL), and the symptoms are closely allied.

Phenols form a distinct group in which carbolic acid, creosote, creolin, lysol, resorcin, pyrogallic acid, thymol, guaiacol, naphthaline, salol, etc., belong. They cause symptoms closely resembling one another. Carbolic acid may be taken as the type. This causes gastro-enteritis, with severe pain, white scar of lips and throat, buzzing, dizziness, smoky to blackish urine, pale, bluish face, weak heart, quick breathing, coma and sometimes convulsions. Treatment is by quick washing of the stomach. A mixture of lime and sugar of syrupy consistency, Epsom salt, milk, white of eggs, cardiac stimulants and artificial respiration are all valuable.

Another large group of poisons, the anilines, includes many of the modern drugs, such as acetanilid. Closely allied are different aniline dyes. Also phenacetin, antipyrin. In these the characteristic signs of poisoning are somewhat similar to those seen in the phenol group, but in the more pronounced ones of this series the main changes occur in the blood. There is blueness of the skin and lips, difficulty in breathing, sometimes pinkish to purplish urine, rapid and feeble heart action. The chief changes are due to a partial destruction of the red blood-cells. In phenacetin the blood rarely disintegrates as in antifebrin or acetanilid; whereas in antipyrin there is no real blood action. The treatment of these forms is by prompt evacuation, cardiac stimulation, oxygen and, most important of all, artificial respiration.

Alkaloidal poisons (see ALKALOIDS) are numerous. The commonest forms of poisoning from these, the most powerful poisons, are morphine (opium, laudanum, paregoric), strychnine (nux vomica), atropine (belladonna), cocaine (coca), aconitine (aconite) and nicotine (tobacco). In acute opium poisoning the classical symptoms are drowsiness, coma, small pin-point pupils, loss of pain, slow breathing (six to eight to a minute), moist skin, dry mouth, rousing with more or less active consciousness and quick relapse. Treatment is by washing the stomach with hot strong tea or coffee, by mouth or by rectum, and by artificial respiration. Too much walking of the patient about is not desirable.

Strychnine poisoning causes twitching of muscles, cramps, irregular muscular movements, convulsions at slightest jar or touch, fixation of muscles of breathing, with cyanosis. Treatment is by great quiet, alcohol, chloroform and stimulants.

Belladonna poisoning shows wide-awake, restless consciousness, sometimes active, busy delirium; dry mouth, skin hot and flushed, pupils widely dilated and paralyzed to light and accommodation, rapid feeble heart and rapid respiration. Treatment is by prompt evacuation of stomach, sodium bromide, opium, caffeine or coffee.

Another group of glycoside poisons is characterized by a great similarity in action. Many of these are used in medicine and some were used as arrow-poisons by wild natives. This group contains digitalin (digitalis), strophanthin (strophanthus), convallarin (lily-of-the-valley), bryonin (bryonia), apocynin (dogbane), oleandrin (oleander), scillain (squills), etc. These are all heart poisons. They first quicken the heart, then slow and regulate it, hence their usefulness in many heart diseases; but in overdoses they paralyze the heart by overstimulation. As these drugs rarely cause poisoning, the treatment is omitted.

Tox albumins form a group of special character, and all are very violent. Some are of vegetable and others of animal origin. The most important are abrin (in jequirity-seeds), ricin (from the seed-coats of the castor-oil bean — frequently causing death in children who eat the whole bean), phallin (in poisonous mushrooms), rattlesnake poison, cobra poison, heloderma and the poison of lizards. etc.

The most important of the bacterial toxins, some of which might be classed here, are discussed under their respective heads. For the endogenous intoxications see the articles on the infectious diseases, cholera, diphtheria, tuberculosis, pneumonia, tetanus, typhoid, etc.; also the diseases of metabolism, uræmia, diabetes, Basedow's disease, Addison's disease — thyroidism, myxœdema, cretinism, etc. See TOXINS AND ANTITOXINS.

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SMITH ELY JELLIFFE, M.D.,
Editor of 'Journal of Nervous and Mental Diseases.'

TOXINS AND ANTITOXINS. Mitchell and Reichart (at the University of Pennsylvania) first demonstrated that the poisonous constituents of snake venom are proteins, or closely related bodies. This statement did not meet with favor in Europe, especially in Germany, at the time, but further studies have confirmed it and it is now a well-established fact that some of the most powerful poisons known are proteins, or at least so closely associated with proteins that all attempts to obtain them free from proteins up to the present time have failed. Such bodies have been found in animal, vegetable and bacterial life, but are limited to certain genera and species. In 1887 Sewall (at the University of Michigan) reported a research which should be recorded as the first step in the discovery of methods of securing immunity to the action of these protein poisons, now known as toxins. Sewall studied the effects of the venom of the rattlesnake on pigeons. Having ascertained the minimum fatal dose of this poison he at first administered less than this quantity, and, by gradually increasing the dose, established an immunity which enabled the pigeons to bear without apparent harm many times the minimum fatal quantity. That this investigator at the time appreciated the possible bearing and significance on protection against disease of his results is shown by the following quotation from his report: «This work was undertaken with the hope that it might form a worthy contribution to the theory of prophylaxis. I have assumed an analogy between the venom of the poisonous serpent and the ptomaine produced under the influence of bacterial organisms.» In 1891 Ehrlich, in a similar manner, succeeded in establishing in animals a high degree of immunity against two of the most potent protein vegetable poisons known — ricin, from the castor bean, and abrin, from the jequirity bean. One gram of ricin is sufficient to kill one and one-half million guinea pigs, and the potency of abrin is about one-half that of ricin. To these poisons immunity, as Ehrlich demonstrated, is easily established by feeding the animals by the mouth upon small and gradually augmented doses. While these vegetable products differ from snake venom in being absorbable from the alimentary canal, the resemblance in potency and in the production of immunity is striking. Moreover, like snake venoms these are protein poisons. Ehrlich made two important advances over preceding workers. He found that the immunity produced with these substances is specific. An animal immunized to ricin has no immunity to abrin, and vice versa. It was later found that this specificity holds good with all poisons of this class. In the second place, Ehrlich found that the blood serum of the immunized animal contains the immunizing agent, and that transference of this serum to a fresh non-treated animal confers a passive immunity upon the recipient. Moreover, this transferred immunity is quantitative. If the first or actively treated animal has been given an immunity of 10 times the fatal dose, and no more, then one-tenth of its blood will be required to give the fresh animal immunity to one minimum lethal dose, while if the actively treated animal has been immunized to 100 fatal doses, one-hundredth of its blood serum will immunize a fresh animal to one fatal dose, and one-tenth of its serum to 10 fatal doses. Furthermore, he found that the immunity of an actively treated mother may be transferred to the nursing young through the milk. Roux and Yersin of the Pasteur Institute found that cultures of the diphtheria bacillus, especially cultures four or five weeks old, when freed from the living organism by filtration through porcelain, contain a poison similar in many respects to snake venom and the vegetable products ricin and abrin. The bacteria — free cultures — when injected into guinea pigs even in minute doses, killed the animals in the same time and with the same symptoms and lesions that result from inoculation with the living organism. Von Behring later immunized larger animals, first goats, then horses, to filtered diphtheria cultures, and demonstrated that the blood of animals thus immunized has both protective and curative value in the treatment of diphtheria.

The toxin of diphtheria is prepared by growing a virulent culture of the diphtheria bacillus at 38°C. for two weeks or more and then removing the bacteria by filtration. In other words, diphtheria toxin is an old filtered culture of the diphtheria bacillus. The potency of the toxin solution depends upon many conditions, all of which must be considered when one attempts to secure a highly active product. The medium generally employed for the growth of the diphtheria bacillus consists of beef tea containing 1 per cent of sodium chloride, from 1 to 3 per cent of peptone, and made feebly alkaline with a solution of sodium carbonate. This medium is placed in glass flasks, each of which should not be more than one-third full in order that there may be a large surface exposed to air which favors the growth of the bacillus and the production of toxin. The flasks are inoculated by floating small masses of diphtheria bacillus growths, taken from agar tubes, on the surface of the beef tea in the flasks. After having been thus inoculated, the flasks are kept at 37°C. for about 14 days, when they are filtered and the filtrate constitutes the diphtheria toxin. The toxin solution quickly loses its potency when freely exposed to air and light, but when properly protected it remains without material deterioration for months, and under most favorable conditions, for years. Protection is secured by covering the toxin solution kept in dark bottles with a layer of toluol. In this way both air and light are excluded. Protection is made more complete by keeping the bottles in a dark room, the temperature of which does not rise above 15°C. When portions of the solution are to be used, withdrawal is made by sterilized pipettes introduced through the layer of toluol. Under these precautions, the toxin solution may be kept without marked loss in toxicity for two years or even longer. Before the toxin prepared as stated above is used in the preparation of antitoxin, its strength must be determined. This is done by ascertaining the minimum amount of it necessary to kill a guinea pig of from 200 to 300 gram-weight within from three to five days. This amount is known as the minimum lethal dose. In most laboratories engaged in the preparation of diphtheria antitoxin, the toxin is not regarded as sufficiently potent unless the minimum lethal dose does not exceed 0.02 cubic centimeter. However, it is not always easy to secure a preparation of such high potency, and weaker solutions may be used. Occasionally a much stronger product is obtained, and when this happens the preparation is greatly prized and carefully kept under the conditions mentioned above. Horses free from disease are carefully selected by skilled veterinarians. Usually they are submitted to a malein test to be sure that they are free from glanders. During the procedure the animals should be carefully guarded against wounds however slight, since these may serve as ports of entry for tetanus infection. Into these horses the toxin solution is injected, at first in small amounts. The first dose is usually followed by a transient disturbance in health. This may be slight, and indeed may not be in evidence at all. However, often after the first dose the animal's coat roughens, the appetite is impaired, and it may show some elevation of temperature. When there is complete return to health, usually after three or four days, a second injection of the toxin is made. It is safer to make the second injection no larger than the first. Indeed, the practice is to make the second injection slightly less than the first. In this case there is usually no recognizable disturbance in the well-being of the animal. After the third or fourth treatment the quantity of toxin used can be rapidly increased and it soon develops that the animal bears without apparent effect many times the amount which if used without previous treatment would have caused death. After this condition of immunity has been secured, a portion of blood is drawn from a vessel in the neck of the horse, allowed to coagulate, and the separated serum tested for its antitoxic strength. This process is known as the standardization of the antitoxin. The procedure consists in ascertaining how much of the blood serum of the treated horse is necessary to neutralize 100 minimum lethal doses of the toxin. The serum of the horse and the toxin are mixed in varying proportions in vitro, and the mixture injected into guinea pigs of from 200 to 300 grams weight. The amount of toxin taken in these mixtures represents 100 minimum lethal doses, and the minimum amount of serum which must be added to this so that the mixture will have no effect on the guinea pig is known as an immunity unit. It will be seen from what has been said that the filtered culture of the diphtheria bacillus constitutes the toxin, while the blood serum of the immunized horse constitutes the antitoxin. Both of these are standardized, and one neutralizes the other quite as effectively as acid neutralizes alkali. Diphtheria antitoxin, which is the blood serum of an immunized horse, is put on the market in tubes fitted with hypodermic needles and ready for use without transfer. This avoids the possibility of contamination after the preparation leaves the laboratory of the manufacturer. Such containers are labeled showing the number of immunity units contained, and this is wholly without reference to the amount of fluid in the tube. When such a preparation is labeled "5,000 Immunity Units" it is to be understood that all the fluid in that tube, whether it be 5 cubic centimeters or more, contains enough antitoxin to neutralize 5,000 times 100 minimum lethal doses of the toxin as tested on a guinea pig. The practice of medical men most skilful in treating diphtheria is to use an antitoxin of the highest obtainable potency, and doses of from 20,000 to 40,000 immunity units are now commonly employed.

When a child is suffering from diphtheria, its throat constitutes the flask in which the bacillus is growing and elaborating its toxin. The toxin filters through the walls of the pharynx into the blood. The physician injects under the skin of the child the serum of the immunized horse which he calls antitoxin, and this passes into the blood of the child and neutralizes the toxin absorbed in the throat. Thus, the acid and alkali are brought together and a harmless product results. The toxin being neutralized as fast as it is absorbed from the throat, does not attack or injure the body cells of the child. It must be evident that the earlier in the infection the neutralizing agent can be used, the more satisfactory is the result. Here, hours count. It has been shown that when the antitoxin is injected into the child on the first sign of the disease the percentage of recoveries is 100. Out of 2,428 cases studied by Hilbert the percentage of deaths varied with the day on which the antitoxin was administered as follows:

First day	2.2
Second day	7.6
Third day	17.1
Fourth day	23.8
Fifth day	33.9
Sixth day	34.1
After the sixth day	38.2

According to Wernicke the saving of lives during the first year of the use of diphtheria antitoxin in Germany amounted to 20,000, and if the agent were promptly and properly used the saving of lives would amount in that country to 45,000 annually. The value of diphtheria antitoxin is even greater than is indicated by the lowering in the death rate from this disease. For every sick child treated with antitoxin, on an average five are saved from being sick. While the curative value of antitoxin is great, its preventative value is still greater. The physician called to a family in which one child has diphtheria gives a curative dose of antitoxin to the sick child and immunizing doses to the others. Even when the sick child has been neglected so long that the curative value of the antitoxin is lost, its preventive value in the others is still potent. Diphtheria antitoxin has lowered not only the mortality rate but still more the morbidity rate. In 1880, before the discovery and employment of this agent, deaths from diphtheria in the registered area of the United States amounted to 112.6 per 100,000; in 1913, after the general employment of diphtheria antitoxin, it was 18.8. Certainly it is no axaggeration that the discovery of diphtheria antitoxin is one of the most beneficent of all agents, and it could not have been made without animal experimentation. The preparation of this agent necessitates the annual sacrifice of the lives of hundreds of guinea pigs, and it leads to the saving of the lives of thousands and tens of thouands of children.

State and municipal laboratories are employed in the detection and recognition of diphtheria, and antitoxin is furnished free to those who cannot afford to pay for it. When a physician sees a case which he suspects to be diphtheria he makes a swab from the throat of the child and transfers this in a sterilized test tube to the municipal laboratory. Here a culture is made and after 12 hours a positive statement can be furnished as to the nature of the disease. Even this delay is unnecessary if the physician is sufficiently confident that he has a case of diphtheria to deal with. Under proper precautions there is no danger in the administration of this agent. In the more enlightened communities school medical inspectors are constantly on the watch for the first evidence of this disease and the child of the poorest citizen is transferred and treated in a municipal hospital with as much skill and care as the richest can secure. Since diphtheria toxin has not been obtained in a pure state, its nature, so far as its chemistry is concerned, remains unknown. There is still doubt as to in just what group it should be classified. Usually it gives at least some of the general protein color tests, but preparations have been secured which do not respona, altogether at least, to these tests. The molecular weight of the toxin is much less than that of the antitoxin because the former filters readily through porcelain and diffuses quickly through gelatin, while the antitoxin is largely removed from solution by filtration through porcelain and does not diffuse through gelatin. From these facts it is inferred that the molecule of the antitoxin is much larger than that of the toxin. The toxin is highly susceptible to heat, a temperature of 60°C. being sufficient to markedly reduce, although it does not wholly destroy its toxicity. A like effect is induced by the presence of both mineral and vegetable acids. Even lactic and tartaric acids speedily render it inert and its toxicity is reduced, although not completely destroyed, by borax and boric acid. It is highly susceptible to the action of oxidizing agents such as potassium permanganate, chlorine, iodine, etc. It diffuses through parchment but does not pass through animal membranes or collodion sacs. It is insoluble in alcohol, and prolonged contact with this agent destroys its toxicity. It is also robbed of its virulence by the digestive ferments present in the alimentary canal, and therefore is harmless when taken into the mouth, provided there is no break in the continuity of the mucous membrane. From solution it is carried down mechanically on the addition of calcium chloride, which precipitates calcium phosphate. In this respect diphtheria toxin closely resembles the enzymes. There are other respects in which this resemblance is evident. Some of these are as follows: (1) It is destroyed by heat; (2) in its purest preparation it does not respond to all the tests characteristic of proteins; (3) it is active in high dilutions; (4) it is a product of cell activity; (5) when introduced into the body there is a period of incubation before the development of its effects; (6) when introduced into animals in progressively augmented doses it leads to the production of an antibody.

The chief objection to accepting the theory that toxins are enzymes or ferments lies in the fact that in their action on animals and in their reactions with their antibodies their effects may be measured mathematically and follow the law of multiple proportion. In other words, the toxins do enter into the reactions and are exhausted or neutralized in doing so. On the other hand, the weight of evidence is that enzymes or ferments do not enter into the reactions caused by their presence and that they are not consumed in such reactions. For instance, the hydrolytic enzymes, such as diastase and pepsin, cause starch and protein to take up water and pass over into sugar and peptone while the enzyme itself does not enter into the reaction and is not consumed in the process. It might be stated differently as follows: An enzyme changes the tempo of a reaction which would more slowly occur without its presence, while a toxin combines with its antibody much as an acid combines with an alkali.

When a fatal dose of diphtheria toxin is injected into a susceptible animal, such as a guinea pig, there is a period of incubation during which the animal shows no marked departure from the normal. This incubation period varies somewhat with the size of the dose, but is never less than about eight hours, even when many times the fatal dose has been used. However it should not be inferred that nothing happens during this period of incubation. The disturbance simply does not rise to the plane of gross clinical observation. The toxin begins to act soon after its introduction into the body. Within an hour or two the clinical thermometer, which is not a highly delicate indicator of changes in temperature, shows an elevation which proceeds slowly until a short time before death, when there is a progressive and rather rapid fall in temperature which may reach some degrees below normal before death. The skin about the point of injection becomes edematous and later necrotic. The interval between injection of the toxin and death is the same as after inoculation with the living organism. When sublethal doses are given there is often paralysis, beginning in the posterior extremities and gradually extending over the body. The internal organs are hyperemic, with minute hemorrhages in the adrenals, stomach and intestines. Occasionally a gastric ulcer is produced. Diphtheria toxin apparently has a special avidity for nervous tissue. Whether this action is primarily central or peripheral has not been satisfactorily determined, though it is most probably the latter. When the toxin is injected into a susceptible animal it soon disappears from the blood current and manifests its activity on certain organs and tissues. It has not been found in the urine except when massive doses have been given. In unsusceptible animals it remains for a long time in the blood stream and is of course without action on the tissues, and it is for this reason that the animal is refractory. Animals differ widely in their susceptibility to diphtheria toxin. This is true of individuals, and still more markedly true of species. The most susceptible animal is the guinea pig. Horses, sheep and goats are susceptible, while rabbits are less so, and white mice practically refractory.

The toxin is a secretion of the living bacillus and different strains of the organism vary widely in the amount of toxin which they elaborate. There is apparently no constant and fixed relation between the virulence of a given strain of the bacillus and its toxin production. A strain isolated by Park of New York, and generally known as Park No. 8, has proved in both American and European laboratories to be a most efficient toxin producer. It was obtained from a relatively mild case of diphtheria and it has shown no great virulence as tested by the experimental inoculation of guinea pigs. With this strain filtered products have been obtained with as low a minimum lethal dose as 0.0015 cubic centimeter. However this strain sometimes fails to produce a satisfactory toxin. Through another strain Madsen once reported a toxin whose minimum lethal dose was as low as 0.0005 cubic centimeter. This is the most powerful diphtheria toxin yet reported. The cellular substance of the diphtheria bacillus contains a protein poison, as was first shown in the writer's laboratory. Against this poison diphtheria antitoxin has no neutralizing effect and it must be regarded as a poison, but not a true toxin. It will be seen that the word toxin has come to have a distinct and specific meaning. All toxins are poisons, but all poisons are not toxins. Those poisons which when injected into animals in gradually augmented doses produce antibodies are known as toxins. The serum of horses immunized to diphtheria toxin, and known as diphtheria antitoxin, is usually preserved by the addition of 0.5 per cent phenol or 0.3 per cent tricresol. Filtration of the serum through porcelain removes the antitoxin on account of the large size of its molecules. Heating antitoxin to from 60° to 70° C. destroys its value, but the dried antitoxin will bear a temperature of 110° C. for half an hour without injury. Diphtheria antoxin is quite certainly a protein. It is true that it bears some resemblance to ferments. It is in and of itself perfectly harmless to the animal body. All disturbances which may result from the administration of diphtheria antitoxin are due to other constituents of the serum and may be induced by the use of the serum of a normal horse. The antitoxin may be precipitated from the serum by metallic salts as other protein constituents are, but it is not carried down mechanically as happens to the toxins and the ferments. It is more than probable that the antitoxin is a globulin. It is precipitated with this protein fraction, and the concentrated antitoxin has been prepared by this method. Unfortunately the immunity induced by diphtheria antitoxin is only temporary, lasting from three to four weeks, while one attack of diphtheria does not give immunity to another. For this reason it frequently happens that a child who has once had an immunizing dose may, a few months or possibly a few years later, need a curative dose. The fear of anaphylactic shock has led many physicians to hesitate about a «reinjection» of horse serum after an interval of 10 days or longer, but with proper care one may do this with safety. In all cases of «reinjection» after an interval of 10 days or longer one drop of the antitoxin should be administered and if no untoward symptoms follow within an hour, any amount of the serum may be injected with safety. This procedure should be adopted not only in all cases of «reinjection» but when the patient has shown at any time asthmatic symptoms. With these precautions no physician need fear to use diphtheria antitoxin in the treatment of this disease. When antitoxin is used early in the disease the extension of the membrane in the throat usually stops in a few hours. For this reason laryngeal diphtheria is now rarely seen except in neglected cases. Not only does the extension of the membrane stop on the administration of the antitoxin, but as a rule that already formed begins to recede, becomes detached and fades away.

In all civilized countries the manufacture of diphtheria antitoxin is under government control. In the United States this is one of the functions of the United States Public Health Service. No one can manufacture diphtheria antitoxin without a permit from this service and such permits are not granted until personal inspection has convinced the service of the reliability and scientific intelligence of the manufacturer. Besides this, every batch of diphtheria antitoxin prepared is tested not only by the manufacturer but in the Hygienic Laboratory at Washington. It is highly essential that the preparation and standardization of so valuable an agent as this should be under government control.

Tetanus, or lockjaw, is one of the most strikingly distressing and fatal diseases known. Therefore it is not strange that it is mentioned in some of the earliest medical writings. It was known to the writers of classical times that tetanus was in some way connected with wounds and that it was much more common in military than in civil life. Furthermore, it has long been known that the frequency of the development of tetanus does not run parallel with the extent or gravity of the wound. Indeed it is more likely to result from a trivial penetrating wound than from a large open one. The infectious nature of this disease was first demonstrated by French physicians, especially Verneuil. However the experimental transfer of tetanus was first made by two Italian physicians, Carle and Rattone, in 1884. They inoculated 12 rabbits with matter taken from a pustule on a man who had tetanus. Within a few days 11 of these animals developed the disease, and from these it was transferred to other rabbits. Soon thereafter Nicolaier induced tetanus in rabbits, guinea pigs and mice, by inserting bits of earth under the skin. This investigator also discovered the specific bacillus, but failed to separate it from associated bacteria. This was done by a Japanese bacteriologist, Kitasato. The tetanus bacillus develops spores which are highly resistant to heat and other adverse agents and may retain their vitality quite indefinitely. In some localities 100 per cent of rabbits inoculated with the soil develop this disease. As a rule, the spores are most abundant in filthy soil, especially that richly impregnated with horse manure. Before the days of aseptic surgery tetanus was especially prone to follow operative procedures, as was noted by Larrey, Napoleon's great surgeon, and many other operators both in the field and in hospitals. Among certain primitive dirty people tetanus of the newly born is frequent on account of the methods of cutting and dressing the cord. On certain islands, as Réunion and Cayenne, the infantile death rate from this cause has in some years been as high as 50 per cent. In other localities tetanus works havoc among women in the puerperal state. Some savage tribes smear their arrowheads with mud rich in tetanus spores. The marked mortality from Fourth of July celebrations in this country a few years ago was due to tetanus infection. Fortunately the barbaric rites with which we were accustomed to celebrate the birthday of our nation have been beneficially modified, largely through the knowledge spread by the *Journal* of the American Medical Association. The parts of our country most abundantly infected with this virus seem to be the Atlantic States, especially Long Island and the Valley of the Hudson. Commercial gelatin and catgut used by surgeons have been the bearers of this infection, and most thorough sterilization is necessary in order to destroy the spores. Formerly we spoke of idiopathic and traumatic tetanus. Now, we are quite sure that the former does not exist. The wound may be so trivial that it is healed before symptoms of the disease develop. In other cases the wound may not be on the skin, but on a mucous membrane, as in the mouth, nose or throat. The writer saw a case in which the virus had entered through the gum from which a tooth had been extracted. It has been claimed that tetanus is more prevalent in black and mixed races than among whites, and some have endeavored to show the existence of racial susceptibility. The truth is that filthiness is the predisposing agent rather than a racial difference. The simple custom of drying the wash by spreading the clothes on the ground has been found to play a part in the prevalence of this disease. The distribution of the tetanus virus seems to be world-wide. It has been found in every land, in the temperate and torrid zones at least, and in many waters such as those of Lake Geneva and the Dead Sea. It may be present in bilge water and men on ships have been infected from this source. Many years ago on an English ship after a naval battle 16 of the wounded died of tetanus. It may be carried into wounds with bits of infected clothing or with the dirt on the skin, and it has been found on nearly every article worn by the soldier, from his shoes to his collar. Virgin forest soil has generally been found free from this virus, but the sweepings from the streets, stables, houses, boats and cars frequently produce tetanus when introduced under the skin of animals. Of our domestic animals, the horse is the most susceptible and is a frequent victim. The ox comes next, followed closely by sheep and goats. Dogs and cats are not easily infected, but do succumb to inoculation. When swallowed, the tetanus bacillus has no effect unless there be some break in the mucous membrane and it is eliminated with the fæces unchanged. In this way the fæcal matter of men and animals pollutes the soil.

Tetanus toxin, one of the most potent poisons known, is prepared by growing the tetanus bacillus in bouillon or blood serum under anaerobic conditions. The bacillus is removed by filtration and the filtrate constitutes the toxin. It is of delicate nature and is easily destroyed by both physical and chemical agents. Light and air rapidly render it inert. Even in filtration of the culture both light and air should be excluded. According to Kitasato, exposure to sunlight completely destroys the toxin within from 15 to 18 hours. Other investigators have reported the time as only half of this. Oxidizing agents such as dilute solutions of potassium permanganate, mineral and vegetable acids, destroy it promptly. From its solution in the filtered cultures tetanus toxin is thrown down on the addition of ammonium sulphate, and by dialysis and evaporation in vacuo it can be obtained in dry form, not pure but mixed with the proteins carried down with it by the reagent. The purest preparations yet made still give the protein reactions and there are those who claim that the toxin is an albumose, but this does not necessarily follow. According to Brieger and Cohn, the fatal dose for a mouse is about 0.0000005 gram and for a man, about 0.00023 gram. It requires 2,000 times as much of the poison per kilo of body-weight to kill a rabbit as it does to kill a horse, and the chicken is 100 times less susceptible than the rabbit. It is highly poisonous when introduced subcutaneously or intravenously, but is most potent when administered subdurally or intracerebrally. This is due to the fact that it has a predilection for nervous tissues. It has been shown quite conclusively that when injected subcutaneously the toxin is conveyed to the nerve centres through the axis cylinders of the motor nerves, and that symptoms of tetanus first develop when the anterior horns of the spinal cord are reached. This explains why there is always a period of incubation, both after subcutaneous injection of the toxin and as a result of wound infection with the bacillus. It also makes plain the observation so frequently recorded that the period of incubation is shorter the nearer the site of inoculation is to the central nervous system. That tetanus toxin does combine with certain constituents of the central nervous system was demonstrated some years ago by Wassermann who found that when the toxin is rubbed up in a mortar with brain or spinal cord tissue it is completely fixed and neutralized. In other words, it forms a compound with some constituent of this tissue. This is probably what happens when the poison is generated by the bacillus in the animal body and as a result of the injury thus caused to the nervous tissue tetanic spasms occur. A tetanus antitoxin is prepared in a manner similar to that employed in the preparation of diphtheria antitoxin. Unfortunately, however, the brillant practical results obtained in the treatment of diphtheria have not been secured in the treatment of tetanus. The value of tetanus antitoxin as a protective agent has been recognized for many years and has been fully confirmed in the treatment of the wounds of the World's War. Before the United States entered the war, American laboratories were busy supplying the armies of the Allies with this material. Soldiers received a protective dose before they went into battle and all wounded were treated with this agent as soon as possible. In this way a high death rate from tetanus has been avoided, notwithstanding the fact that a large proportion of the wounds are infected with the bacillus. If one waits until symptoms of tetanus have developed the administration of the serum fails in a large proportion of the cases to effect a cure. However, even under this condition the treatment is not wholly without value. The cessation of trench warfare was followed by a notable decrease in the number of wounds infected with the organism of this disease.

In certain parts of Germany, especially in Württemburg and neighboring parts of Baden and Bavaria, where sausage, a favorite article of diet, has been imperfectly cured and eaten raw, poisoning from this article of food has long been known. Rarely, similar cases have occurred among those in the United States who persisted in the Old World method of preparing and eating sausage. As a rule, food which produces this form of intoxication has been prepared for a long time before it is eaten. The disease thus produced is known as "botulism" and it should be clearly understood that this does not include the ordinary form of food poisoning which leads to vomiting and purging and generally ends in recovery. In 1885, some 30 cases of botulism developed in a small Belgian village and were studied by Van Ermengem of Ghent. In this instance, the food was a ham which had been kept in dilute brine. It was from a sound animal, other portions of which had been eaten while fresh without harm. In fact the companion ham, from the same brine, had been eaten without disturbing those who had partaken of it. The sound ham lay near the surface and was not wholly covered by the brine while the faulty piece lay on the bottom of the vat and was completely excluded from the air. It was not noticeably decomposed, but was marked by soft colored spots and gave off the odor of butyric acid. In this meat the bacillus botulinus was found. An aqueous extract of the ham was injected into animals and proved to be intensely poisonous. In cats it caused dilatation of the pupils and abundant mucous secretion in the mouth and pharynx, prolapse of the tongue, roughness of the voice followed by complete aphonia, difficulty in swallowing and paralytic symptoms resulting in death within from four to eight days. Mice and guinea pigs, rabbits and apes were affected in much the same way. The apes were found to be equally susceptible when fed by mouth, while cats, rats, dogs and chickens were not susceptible when fed. Other outbreaks due to the same cause have been reported from time to time in this and other countries.

The bacillus botulinus is strictly anaerobic, except when grown with other organisms which consume the air. It grows only feebly at animal temperature, but at lower temperatures and when the air is excluded it develops its toxin. It will be seen that it does not cause an infection but an intoxication. Indeed, the bacillus does not multiply in the animal body, or does so only to a slight extent. It is a toxicogenic, rather than a pathogenic, organism. A striking characteristic of this toxin is that it affects some animals, including man, when taken by the mouth. It also has a predilection for nervous tissue. According to Marinesco and others it induces marked changes in the cells of the anterior horns, leading to chromatolysis, and disintegration of Nissl's granules. Like tetanus toxin, it combines in vitro with nervous tissue, forming an inert compound. An effective antitoxin has been prepared and has proved efficient in animal experimentation. The writer is not aware that this antitoxin has been used in the treatment of botulism in man. This toxin may occur in canned vegetables as well as in meats. There was quite a scare in the United States in 1917 concerning the possibility of botulism being widely prevalent on account of the new methods of preserving food proposed at that time by the Agricultural Department. This fright has not been justified by subsequent events. Apparently the bacillus botulinus is not widely distributed. So far, it has been found only once except in food and that was in the fæces of hogs. As has been stated, it grows only in the absence of air or in association with other organisms which consume the air, and it has been found in canned foods. In such, it produces gas which bulges the ends of the can and food from such containers should not be eaten. In brine of more than 10 per cent strength it will not grow. It is of special interest because it is essentially a saprophytic organism producing in food in the absence of air a most potent poison which affects man when taken into the stomach.

Reference has already been made to the fact that the toxins were first found in the venom of snakes. Antitoxins to these venoms have been prepared, their value demonstrated experimentally on animals, and some slight use of these preparations have been made in the treatment of men bitten by poisonous snakes in India. However, these antitoxins like all others are strictly specific and an antitoxin must be prepared for the venom of each species of poisonous snake. The rarity of death from this cause in most parts of the world and the difficulty of preparing and keeping on hand an antitoxin for the treatment of the bite of each species limits the use of this preparation. Within recent years an antitoxin has been prepared and used successfully in the treatment of cerebrospinal meningitis. In this instance a definite amount of fluid is withdrawn by puncture under aseptic precautions from the spinal canal and is replaced by the injection of the antitoxin. Furthermore, it has been demonstrated in our own camps during the war that the intravenous injection of this antitoxin is beneficial.

Scientific investigations and experimental studies on animals have given to man almost absolute control of diphtheria and of such enteric diseases as typhoid fever and its allies. Tuberculosis, formerly known as the "Captain of the Hosts of Death," has been greatly curbed but to-day pneumonia,— or as we should say, the pneumonias,— is the mostly deadly disease that we have to deal with in both military and civil life. The medical profession has recently come to a realization of the fact that etiologically there are many forms of pneumonia. In the first place, there are several types of the pneumococcus. In the second place, other organisms belonging to the streptococcus and staphylococcus groups may cause pneumonia. In the Rockefeller Institute there has been prepared a serum for the treatment of that form of pneumonia due to pneumococcus Type I. Animals have been immunized to this organism and the sera of such animals have been used in the cure of this disease. However, it is not certain at present that such sera have true antitoxic values. Some claim that the sera of animals immunized with this type of pneumococcus have a bactericidal action, while others think that they only render phagocytic action more effective. In order to be of service in the treatment of pneumonia due to pneumococcus Type I, a relatively large amount of the serum must be used. In other words, a certain degree of concentration must be reached. The law of multiple proportion which holds good between diphtheria toxin and its antitoxin fails here. Our experience in the World War has demonstrated the great destructiveness of the pneumonias and the lesson that we have learned should lead to the greatest effort toward the discovery of both preventive and curative measures in these diseases. On the battlefields of France the gas bacillus, known also as the Welch bacillus, proved a most distressing and destructive agent. Shortly before the war closed Bull and Pritchett at the Rockefeller Institute discovered an antitoxin for the poisons of this organism and fully demonstrated its value in experimental animals. The cessation of trench warfare led to a rapid reduction in the number of wounds infected by this organism and the time has not yet come for a correct estimate of the practical value of the antitoxin. See IMMUNITY; MEDICAL SCIENCE AND THE WORLD WAR; SERUM THERAPY.

VICTOR C. VAUGHAN,
Dean, Department of Medicine and Surgery, University of Michigan.

TOXODON, a genus of large Pleistocene mammals whose complete remains are found in the Pampas formations of Argentina. They were about the size of a hippopotamus; the teeth consist of large incisors, very small lower canines and strongly-curved molars, all with persistent roots. According to Cope, the tarsal bones more nearly resemble those of the *Proboscidea* than any other known ungulates. With a smaller genus, *Nesodom*, it constitutes the sub-order *Toxodontia*.

TOY, Crawford Howell, American Oriental scholar: b. Norfolk, Va., 23 March 1836; d. Cambridge, Mass., 12 May 1919. He was graduated at the University of Virginia in 1856, studied in Berlin (1866–68), and became professor of Hebrew in the Southern Baptist Theological Seminary in 1869 and professor of Hebrew and other Oriental languages and lecturer on biblical literature at Harvard in 1880. From 1909 until his death he was professor emeritus. His published works include 'The Religion of Israel' (1882); 'Quotations from the Old Testament in the new Testament' (1884); 'Judaism and Christianity, a Sketch of the Progress of Thought from Old Testament to New Testament' (1890); 'Hebrew Text and English Translation of Ezekiel' (1899); 'Commentary on Proverbs' (1899); 'Introduction to the History of Religion' (1913), and others.

TOYAMA, tō-yä-mä', Japan, the capital of the prefecture of Toyama, situated near the head of Toyama Bay, west coast of Nippon, 170 miles northwest of Tokio. It has considerable trade in drugs and leather. Pop. of the city about 64,822; of the prefecture, 829,596.

TOYNBEE, toin'bē, **Arnold,** English social economist and philosopher: b. London, 23 Aug. 1852; d. Wimbledon, 9 March 1883. He was interested in various movements of popular reform and the betterment of the laboring classes. Though called a socialist, he was certainly a conservative one and vigorously opposed in two lectures the doctrines of the 'Progress and Poverty' (1880) of Henry George (q.v.). Toynbee Hall in Whitechapel, London, was established in his memory in January 1885 and was the first "universal settlement." His writings were posthumously collected as 'The Industrial Revolution' (1884; 4th enlarged ed., 1894). Consult Montague, 'Life' (Johns Hopkins historical series, 1889); Milner, 'Arnold Toynbee: a Reminiscence' (1895).

TOYNBEE, Paget, English critic and author: b. Wimbledon, 20 Jan. 1855. He was educated at Balliol College, Oxford, and from 1878 to 1892 was a private tutor. An Italian scholar, he has been a contributor to *Romania* and the *Giornale Storico della Letteratura Italiana*, and published 'Index of Proper Names in the Works of Dante' (1894–97); 'Dictionary of Proper Names and Notable Matters in the Works of Dante' (1898); 'Ricerche e Note Dantesche' (1899); 'A Critical Text of the Divine Comedy' (1899); besides editions of the three parts of Cary's 'Vision of Dante,' with introductions and notes (1899–1901–02); a 'Life of Dante' (1900; 2d ed., 1901), and 'Dante Studies and Researches' (1902).

TOYNBEE HALL, a social settlement, the first in the world, founded by Canon S. A. Barnett in memory of Arnold Toynbee, who while a student at Oxford became interested in the White Chapel district poor. The settlement was opened in 1884 and was a success from the start, gradually becoming a centre of educational and social endeavor and rallying to its work many of the leading young men of the time. Consult Gell, Philip L., 'Account of the Work of Toynbee Hall in East London' (Baltimore 1889). See SOCIAL AND UNIVERSITY SETTLEMENTS.

TOYS, American, Manufacture of. To tell the story of the art of toy-making from its earliest days it would be necessary to follow the industry back through many centuries, for the archæologists, in delving among the tombs of ancient Greece and Egypt, have made the surprising discovery that children played with dolls—and jointed dolls at that—more than 5,000 years ago. Moreover, by the side of these dolls the scientists have unearthed other playthings that children still crave: dolls' furniture, the utensils for cooking and for keeping shop, and, what is perhaps more interesting from the point of view of the antiquarian, the articles used by the priests in making the sacrifices, cleverly duplicated in miniature, showing that the children of those times also played at having religious exercises for the benefit of their dolls.

Scientists now claim that the custom of playing with dolls is one that is practically as old as the world itself, and they base their assumption upon the theory that playthings are and always have been just as necessary a constituent of human health and development as either food or medicine. The most eminent modern psychologists support this theory. They claim that the reason why children crave toys is that their nature requires them, and that to deprive them of such playthings would be to retard their mental growth and development.

In spite of the early origin of toys the progress in the manufacture of playthings was so slow that even as late as 100 years ago they were few in number, simple of construction and extremely costly, especially in the United States. At that time no such articles were systematically manufactured in this country, and as the cost of importation added materially to the price, there were comparatively few persons who were financially able to purchase such puppets for their little ones. Instead, the children of those days accepted more primitive playthings — dolls that were often not dolls at all, but pieces of cloth, either folded and pinned in such manner as to suggest the «shape» that was not there, or with head and bust stuffed hard with sawdust, the features being indicated by pen and ink drawing. In addition to these dolls there were a few other toys that could be purchased for children, but hoops, jumping-ropes, ten-pins, marbles, pop-guns, the jack-in-the-box the battledoor and shuttlecock, a few simple games, some roughly illustrated books, alphabet blocks, etc., represented the limit of the toy-sellers' stock.

So far as America is concerned the toy-making industry is of so recent an origin that it can scarcely be said to have a history. Before 1875 more than 90 per cent of the toys sold in this country were of foreign manufacture, and we have made no attempt to export such few articles as we did make into other countries. To-day, on the other hand, scarcely 5 per cent of the toys we sell are made abroad, while our exports are increasing rapidly.

To obtain anything like an accurate idea of the great progress that this nation has made in the art of toy-making it is necessary to remember that up to about 1875 there was not a doll factory in the United States, and that such other toys as were manufactured in American turning mills were cheap in quality and unprepossessing in appearance. When the American manufacturers began to make toys, about a quarter of a century ago, they found that it would be extremely difficult for them to compete successfully with the foreign toy-makers in the field which they had occupied for so long. In the first place material was cheaper in Europe, and there could be no comparison between the comparatively good wages paid to workmen in this country and the miserable pittance allowed in those German and Swiss villages where the entire population was held under contract to produce such goods at prices that barely enabled them to keep body and soul together. To overcome this difficulty American inventive genius was called into play, with the result that the local manufacturers not only established many new lines of toy specialties but that they evolved countless ingenious contrivances that the foreign producer has never dreamed of making. Thus while we still import some dainty toys from France and Switzerland, nearly all the newest and most unique productions are now made in America.

Simple toys are made mostly of wood and metal, using the same principles employed by mechanical engineers in the making of duplicate machinery. A design having been decided on, and reduced to its most simple elements, gigs are fashioned so that each piece is a duplicate of every other piece, and the construction is pushed through on the American factory system. Many toys are really model machines, as steam-engines, locomotives, cars, carriages, fire-engines, automobiles, tanks, etc.; others are mere figures or puppets, as the Noah's ark men, wooden soldiers and the like; others are miniatures of common household articles, as chairs, tables, plates, cups, spoons, etc., assured to be proper for the furnishing of a doll's house. Others are very elaborate and costly as goat's carriage, push-mobiles, working locomotives, contractors' machinery, imitation large figures of elephants, dogs and Teddy bears, hobby horses, etc. Some single toys in playthings sell at retail between $100 and $200, which is not considered extravagant by the rich.

The United States census compiles together the manufacturers of toys and games. It is not possible wholly to separate the two, but it appears that there were in 1914 about 200 establishments wholly devoted to toy-making, and as many more partly devoted to the industry, which gives employment to about 5,000 persons, with annual products valued at $8,000,000.

TRACERY, *in architecture,* permanent openwork in a window, the top of a doorway, etc., characterized by geometric and ornamental management of the prominent lines of the design. It is common in the cathedral structures of Europe, especially in the older French and Italian structures. The term is extended to similar decorative work of a conventional character, as on a dado or ceiling decoration.

TRACHEA, trā-kē'ạ or trā'kẹ-ạ, or **WINDPIPE,** the principal air-passage of the body; a tube extending from the larynx to a point opposite the third dorsal vertebra, where the tube divides into two chief divisions or bronchi, one of which supplies each lung with the air necessary for respiration or breathing. The trachea is of cylindrical form and is both membranous and cartilaginous in its structure. Its length is about four and one-half inches and its diameter from three-fourths inch to one inch; that of the male being larger than that of the female. The front or anterior surface of the organ is convex and is covered in the neck and chest by various structures, including the isthmus of the thyroid gland, the inferior thyroid veins, the sternohyoid and sternothyroid muscles, the first part of the sternum, the arch of the aorta, etc. The trachea rests on the gullet or œsophagus, while in the chest it is situated between the pleuræ or membranes lining the thorax and has the pneumogastric nerve on each side. The trachea is composed of rings or zones of a gristly or cartilaginous nature, known as the cartilages of the trachea. It rests on the gullet or œsophagus, while each cartilage forms an imperfect ring, being unclosed behind and having the gristly edges merely joined by fibrous membrane. The cartilages are separated from each other and also connected together by narrow bands of fibrous tissue. The first cartilage of the trachea is broader than the others and may be divided at one extremity, while the last cartilage is thick in the middle and curved backward at the point where the trachea divides into the two bronchi. Sometimes two of the cartilages may unite. The muscular fibres of the trachea exist in longitudinal and transverse layers and are composed of unstriped or non-striated fibres. (See Muscu-

LAR SYSTEM). The trachea itself is lined by delicate mucous membrane, which is covered by epithelial cells provided with delicate vibratile processes or cilia. The trachea derives its blood from the inferior thyroid arteries. Its nerves arise from the pneumogastric trunks and recurrent branches, as well as from the sympathetic system. Foreign bodies falling into the trachea most frequently enter the right bronchus, because of the larger size of the latter and because of the more oblique position of the left bronchus.

Diseases and Injuries of the Trachea.— The trachea is liable to inflammation and its products and frequently suffers from extension of disease from the larynx. Acute inflammation may occur as an idiopathic affection or a symptom of other disease, as smallpox, measles, typhus, tuberculosis, croup, etc. The symptoms are pain in the windpipe from the top of the sternum, expectoration of mucus, sometimes in regular rings and a peculiar brazen-like cough. Chronic inflammation usually accompanies follicular pharyngo-laryngitis, tuberculosis and syphilis, and may extend to the submucous tissues and the cartilaginous structures, resulting in ulceration, cicitrization and stricture. The treatment consists in rest, the application of warm poultices, the inhalation of steam impregnated with balsamic or anodyne substances and the administration of antiphlogistic remedies. Constriction of the trachea may be produced by aneurismal or other tumors pressing externally on the trachea; or the symptoms may be produced by pressure on the nervous trunk or the inferior laryngeal fibres. Foreign bodies occasionally pass through the larynx into the trachea and the accident is a formidable one, which not unfrequently proves fatal. The accident occurs most frequently among children and is caused by a sudden inhalation while holding something in the mouth. Occasionally, however, a foreign body may, during the act of swallowing and without an inhalation, pass under the epiglottis and into the upper part of the larynx. Foreign bodies in the windpipe may be arrested above the rima glottidis, between the vocal cords, in the cavity of the larynx or in the trachea. In such cases the patient is suddenly seized with convulsive cough and dyspnœa. The speech is more or less affected and the breathing is whistling or stridulous; but the diagnosis rests mainly on the sudden accession of the symptoms. When the presence of a foreign body is made out, it ought to be removed at once. When the body is loose in the trachea, a free opening lower down should be at once made and the opening may be either longitudinal or transversely valvular. It is advisable in nearly all cases to open the trachea, as, by securing a free aperture for respiration, spasm of the glottis is obviated and the foreign body may be removed through the artificial opening, or it may fall through the glottis into the mouth. Fracture of the trachea occurs from direct violence and in such cases the wounded part should be laid freely open, so as to secure the passage of air to the lungs. Union of the wound by suture is to be avoided, that by suppurative inflammation being preferable, the head and neck being retained in a suitable position. Foreign bodies in the trachea and all kinds of injury from external violence are serious affections, as disease of the lungs is apt to be induced.

The term trachea as applied in respect to invertebrates connotes a more or less complicated arrangement of air-tubes and spiracles (q.v.), most fully developed in insects and constituting the respiratory system. See INSECTS. For the general subject, see ANATOMY; LUNGS; NOSE AND THROAT; RESPIRATION.

TRACHEOTOMY. See NOSE AND THROAT.

TRACHOMA. See OPHTHALMIA.

TRACHYTE, trā'kīt, an igneous or pyrogenic rock of the effusive type and consisting of a ground mass of slender hair-like crystals of orthoelastic feldspar and ferro-magnesian silicates (hornblende or augite) and generally phenocrysts of sanidine feldspar. It differs from rhyolite chiefly in the absence of quartz. Trachyte occurs in the Black Hills, in Custer County, Colo., in Montana, along the river Rhine, where the Drachenfels furnishes the most typical variety, in the Auvergne, in Italy, and in the Azores. The compact pre-Tertiary varieties are classed as felsites (q.v.) or as porphyries.

TRACING PAPER, transparent paper which enables a drawing or print to be clearly seen through it when laid on the drawing, so that a pen or pencil may be used in tracing the outlines of the original. It is prepared from smooth, unsized, white paper rendered transparent by an oily application, as of oil of turpentine with an equal part of Canada balsam, nut-oil, etc.

TRACT NUMBER 90. See TRACTS FOR THE TIMES.

TRACT SOCIETIES. The circulation of religious appeals in writing preceded the invention of printing and was used by Wyclif and other reformers at times and places when and where open preaching might have been too perilous. The printing-press made it possible to multiply such appeals and it was largely used for this purpose in the religious controversies of the 16th and 17th centuries. The 17th century and the beginning of the 18th witnessed the organization of several societies within the Church of England for promoting Christian knowledge and «the dispersion both at home and abroad of Bibles and tracts of religion.» It was not, however, until 1750 that members of different Protestant denominations united in London to form the «Society for Promoting Religious Knowledge Among the Poor.» This and other societies with a similar object circulated many religious books and tracts.

In the United States the Methodist Book Concern, established in Philadelphia, issued its first publication in 1789, and removed to New York in 1804. In 1822 a bindery was established and in 1824 a printing office was added. The division of the Methodist Church on the slavery issue led to the establishment of a separate book concern at Nashville, Tenn., by the Methodist Episcopal Church South. The publications of the Book Concern are of three classes — first, the bound volumes, denominational papers and some pamphlets; second, those of the Methodist Episcopal Sunday School Union, and third, those of the Methodist Episcopal Tract Society. The Concern has developed far beyond the «tract society,» being now a large religious publishing house. The salaries of bishops and other expenses of the Methodist Episcopal Church are paid out of the profits of the Book Concern.

The American Tract Society was founded in the spring of 1825. In this society Christians of various Protestant denominations united to publish and circulate «whatever would best diffuse a knowledge of our Lord Jesus Christ as the redeemer of sinners and promote the interests of vital godliness and sound morality,» the material circulated to be such as would receive the approbation of all evangelical Christians. The society established a system of colportage, gave wide circulation to tracts and sought to place Christian literature in every family. Periodicals were established for young and old and the needs of the large foreign population were met by religious publications in their own languages. The society has contributed from its earnings nearly $1,000,000 to assist missionaries abroad in printing books approved by the society. In donations and legacies the society has received over $7,000,000 and has expended that amount in its gratuitous work, besides printing and circulating over 800,000,000 tracts, pamphlets, books and periodicals, many of which were sold. Among the nationalities reached in their own languages by publications of the American Tract Society are the Swedish, Danish, French, Spanish, Dutch, Italian, Portuguese, Polish, Bohemian, Hebrew, German-Hebrew, Hungarian, Lithuanian, Finnish, Welsh and Armenian. It has furnished religious reading matter to the American soldiers in large quantities. Besides the American Tract Society, every important denomination has an organization for the circulation of its denominational literature.

TRACTARIANISM, the name usually given to a system of religious opinion and practice promulgated within the Church of England in a series of papers published under the title of 'Tracts for the Times,' between September 1833 and March 1841. The immediate object of the writers seems to have been to rouse a large number of nominal adherents of the Church of England from their apathy, by awakening their interest in what the writers conceived to be the distinctive principles of that Church. For this end they sought to mark out a middle way between «Romanism» and what they called ultra-Protestantism. The leaders in this movement were J. H. Newman, John Keble and E. B. Pusey, and they were assisted by not a few devoted adherents, such as R. H. Froude (brother of the historian), Hook, Palmer, Perseval, Isaac Williams and others. In the first stage of the movement little else was attempted than the inculcation of the peculiar and exclusive powers of ministers episcopally ordained by the laying on of hands in a direct and unbroken line from the apostles, and it was not till the publication in 1838 of the 'Remains' of R. H. Froude, under the joint-editorship of Newman and Keble, that any suspicion was created in the public mind of the ultimate tendencies of the movement. The volumes published under that title were pervaded by an unmistakably anti-Protestant spirit, and the fact of their being edited and defended (as they afterward were) by two who were known to be leaders in the Tractarian movement caused that movement to be denounced by many who had hitherto treated it with indifference or forbearance, or had even bestowed upon it a certain measure of approval. From that date the bishops began a series of charges all bearing more or less strongly against the authors of the tracts, and treating them not as heretics but as disturbers of the Church. Still the movement went on more actively than ever. A multitude of controversial writings appeared on both sides, and the tracts gradually showed more and more of a leaning to the Roman Catholic Church. At last, in Tract No. 90, written by Mr. Newman, and published in March 1841, an attempt was made to prove that there is no insurmountable barrier between the Roman Catholic and the Anglican communions; that the Thirty-nine Articles, although prepared by Protestants, are susceptible of a Catholic interpretation not inconsistent with the doctrines of the Council of Trent. On the 15th of the same month the hebdomadal board of the University of Oxford condemned the tract as teaching a mode of interpreting the Thirty-nine Articles inconsistent with the statutes of the university, and the bishop of the diocese of Oxford recommended that the series of tracts should terminate with that number, which it did. A few years later (1845) Newman went over to the Church of Rome, as several of the other partakers in the movement had done before him. The effects of the movement can still be traced within the English Church in the extreme development of ritualism in a section of the High Church. See GREAT BRITAIN — THE CHURCH OF ENGLAND; NEWMAN, FRANCIS WILLIAM; PUSEY, EDWARD BOUVERIE; PUSEYISM; RITUAL.

TRACTION, Electric. The history of the development of electric traction follows closely that of other great technical developments — starting with experiments on a small scale, having no practical outcome, followed by experiments on a larger scale, showing the physical possibility of the system, and finally using the experience so obtained in a successful, commercial application of the system to practical operating conditions. It was not until the invention and development of dynamo-electric machines made it possible to obtain electrical energy at a reasonable cost that the commercial application of electric traction became possible, and even after that, electric machinery had to be improved before electricity could compete with the existing means of traction. Among the first to study the problem seriously were Siemens, in Germany, and Edison, Field, Daft and Vandepoele in this country. Before 1884 a few roads had been built for exhibition purposes and from that time until 1888, although some small roads were equipped with a few cars, yet it had not been proved that electricity could be profitably substituted on tramways for cable or animal traction. In February of 1888 the Sprague Electric and Manufacturing Company finished the equipment of the tramways in Richmond, Va., with the Sprague Electric Railway system, and operated the road so successfully that railroad managers from other parts of the country were convinced that they had something to substitute for animal traction that would increase their facilities for transportation and decrease the cost of operation. From this time the development of electric roads in the United States has been rapid. At first horse tramways were electrically equipped, then cables were displaced by electric trolley roads, then the tramways were extended further to the suburbs and surrounding towns, and towns were connected by interurban roads equipped electrically, running at high speeds and offering a service impossible with steam locomotives. For city train service on elevated roads, the substitution of electricity has taken a longer time, as the steam locomotives were efficient and as the changes involved an expenditure which would not have been advisable unless decided advantages with respect to service and cost of operation were shown.

Direct-current Railway Motors.— On all the electric roads in this country, and on a large proportion of those abroad, direct-current motors are used for traction. These motors are of the series type, and are usually connected to the axle through a single spur gearing. The characteristics of the direct-current series motor are admirably adapted to traction work. The speed is dependent upon the tractional effort, and the motor slows down when the tractional effort increases, having something of the effect of a variable speed gear; this is very important in practical railway work, for if the motors ran at a constant speed, the energy demanded on grades would be greatly exaggerated and much larger motors would be required. It is also true that this type of motor gives a greater flexibility to the system, as far as speed is concerned, and this flexibility is important in practical operation. To show the difference between a series motor and a shunt motor, suppose the track resistance is 10 pounds per ton weight of the car; then if the speed were constant (as would be the case with a shunt motor), the power required on a 5 per cent grade would be 11 times as much as on a level — air resistance being omitted — while with a series motor it would be only three or four times as much.

It might be well to briefly trace the development of electric railroad motors in the United States. The motors used by Sprague in the equipment of the Richmond road had too small a capacity for the work required and very often burned out. They were two-pole machines, of a rated capacity of 7.5 horse power, and at first drove the axle through a single reduction gearing; the work, however, was so heavy that it was found necessary to change to a double reduction gearing, the teeth of the pinion stripping on the heaviest grades. These motors were unprotected from moisture and from the dust and dirt of the streets. The methods of suspending the motor and some of the details of the regulation are still retained. The field magnets of the motor were sleeved on the axle, thus centring the armature on the axle and allowing a satisfactory relation between the two. The first motors had a double commutator, which was soon abandoned, as it greatly increased commutator troubles, which were at that time serious. The brushes first used on these motors were of copper and a number of forms were experimented on, it being necessary to reverse the motor without injuring the commutator. None of the experiments with copper brushes were successful, and it was not until the introduction of the carbon brush by the Thomson-Houston Company that the commutator difficulties were largely obviated.

Soon after the Sprague Company entered the railway field, the Thomson-Houston and Westinghouse companies took up electric railway work, and greatly aided its development by adding their immense resources to the resources of the Sprague Company. From this time the development of street railway apparatus was rapid. The first motors of all the companies used double reduction gearing, and one of the first improvements, after the introduction of the carbon brush, was the design of a comparatively slow-speed motor which allowed a single reduction gearing to be used. The first motor of this kind was made by the Wenstrom Company, and within a short time other manufacturers were making slow-speed motors — some going so far as to attempt gearless motors; the latter, however, were not successful owing to their great weight and lack of efficiency at reasonable speed. Most of the slow-speed motors that were made at this time were not thoroughly enclosed, their efficiency being such that a better ventilation than could be obtained by a totally enclosed machine was necessary. The machines were, as a rule, of the four-pole type, with parallel armature windings, requiring four brushes and causing, under certain conditions, unbalancing in the circuits that greatly increased the armature losses and decreased the efficiency. The next step in motor development was made by the Westinghouse Company in what they called their No. 3 motors, a machine much like those at present in use. It had four poles, each of them provided with a field coil, while the armature was provided with what is called a series winding, necessitating only two brushes and doing away with the unbalanced armature circuits of the earlier machines. This type, with the modifications suggested by experience, is the one used in this country at the present time, and almost universally used abroad.

Controllers.— The first method used for regulating railway motors was by inserting resistance in the circuit of the machine; this was modified and developed until, in the Richmond motors of the Sprague Company, the series-parallel system was used, combined with a variable resistance obtained by making different combinations of the coils into which the field windings of the machine were divided. On starting and for slow speeds the two motors were used in series, while for the higher speeds they were placed in parallel. This system was abandoned, and for some years a parallel system for operating two motors on a street car was used. One difficulty found in the early series-parallel control was the liability of the motors to slip when in series position. The slipping on one pair of wheels would allow the motor connected to these wheels to revolve at such a high speed that its counter-electromotive force would cut off the power from the other, and the car would not start. This difficulty, which always exists, but which is not of importance on ordinary roads, was further complicated by the electrical difficulties in the controller — the method of control not being as efficient as that used at present. In the Sprague system, there was no resistance outside of the motors, but the motor fields were divided into a number of coils, and the relations of these coils were varied, giving first a high resistance and a very strong field for a given current, and afterward a comparatively low resistance and a comparatively weak field. The difficulty of this system lay in the fact that all the heating incidental to the low efficiency of the motors on starting was liberated in the field; and, further, the inductance of the fields was greatest at the breaking of the circuit, when all the coils were in series. The Thomson-Houston Company modified this by placing a variable resistance directly in the motor circuit, the resistance being regulated by a movable contact arm, controlled by the motorman. This gave better results than the Sprague system, but it also lacked efficiency. In 1891 the General Electric Company brought out a series-parallel controller, similar in some respects to the early Sprague control, but differing from it in the fact that the regulating resistances were not obtained by variations of the different motor field windings, but by resistances outside of the motor. This system, with variations due to different conditions of operation, is still used and gives excellent results. Perhaps the most important development in controller work was due to the introduction of the magnetic blow-out devised by Prof. Elihu Thomson. This apparatus is so placed as to control the breaking of the circuits, and almost entirely eliminates the destructive effects of sparking, due to the breaking. The method of operation is as follows: At first the two motors are placed in series, the resistance being also in series with them; then the resistance is gradually cut out, until finally the motors are in series across the line with no outside resistance in their circuits. Then the resistance is again cut in and one of the motors is short-circuited; the next operation cuts out the short-circuited motor, the next places it in parallel with the other motor, a large part of the resistance still being in series with them; the rest of the operations consist in cutting out the resistances until finally the motors are in parallel across the line. The shifting of the circuits, due to the various operations necessary for regulation and cross circuiting, is carefully guarded against by enclosing the different sections in compartments.

Multiple-unit System of Control.— In urban train service, where a number of cars are operated in one train, with frequent stops, the question of acceleration is of the utmost importance. In order to accelerate quickly, it is necessary to have a large margin of tractive effort on the train — that is, it is necessary to have a large proportion of the total weight of the train on the driving wheels. When the question of displacing steam locomotives for elevated railway service first came up, and was attacked on the basis of using electric locomotives, the advantages of the latter were not apparent. There was, of course, some advantage in the matter of expense, but not enough to justify the expenditure necessary to change from steam to electric service. Mr. Sprague devised a system by which a number of cars on a train could be equipped with electric motors and controlled from any one of the cars; this system he called the «multiple-unit» system. At first it was opposed by most of the manufacturing companies and by many electrical engineers. With his customary energy, however, Mr. Sprague worked his system out to a practical demonstration, and to-day all trains operated by electricity employ his fundamental methods. The advantages of this system are these: It gives a large proportion of the total weight of the train on the driving wheels, and at the same time distributes this weight over the whole length of the train. In the first place, this allows rapid acceleration without slipping of the wheels, and in the second place, it does not impose an undue strain on any elevated structure. It is also possible, of course, to change the number of units on a train without changing the relative weights of the driving mechanism of the car. It furthermore utilizes all the train space for the transportation of the passengers. Its disadvantages, compared with a single locomotive, lie in the fact that it necessitates a greater number of motors, thus adding to the cost of installation and repairs, and it greatly complicates the system of control.

In the Sprague system each car is equipped with a controlling device operated by a pilot motor, the motor being operated through a circuit controlled by the motorman. The system is to a considerable extent automatic, as the rate at which the different positions of the controller on each car are changed depends upon the flow of current into the motors, and is not determined by the motorman. This is an important feature of the apparatus and makes the acceleration uniform, and at a rate to give the greatest efficiency. The General Electric method of control is somewhat different from this, each car having a master-controller, very much like the ordinary tramway controller — the speed at which the current is cut into the motors being determined by the rate at which the motorman turns the handle of the controller. In the Westinghouse controller, the apparatus which supplies current to the motor is operated pneumatically, the valves of the pneumatic system being worked by magnets in a local circuit, which has as a source of energy a few storage batteries on each car and is operated by a master-controller on each car of the train. This makes all the operations independent of the line current and gives very positive and efficient action.

Overhead Trolley System.— For collecting the current to run electric cars, a number of devices were used, until finally Sprague's success at Richmond fixed a type of collecting device that is still considered standard in this country and is largely used abroad. Until actually determined by experiments, it seemed impossible that a moving contact device could collect the current necessary to supply the energy to the cars without such destructive sparking and heating that it would be inoperative. In the first experiments on electric railroading, the current was collected from the rails; afterward it was collected through small carriages running on the overhead wire; and finally it developed into a rotating wheel having a contact on the underside of the trolley wire and pressing against it by some spring arrangement. What is called a «bow» trolley was first used — that is, a wire bent into the shape of a bow, pressing against the underside of the wire, but having no rolling contact. This is still used to a considerable extent abroad and presents some advantages over the trolley wheel used in this country. A number of modifications of both of these systems have been devised and employed. The overhead trolley wires, from which the current is collected, are usually of copper; they are either suspended from insulators fastened to a span wire between poles on the two sides of the track, or from brackets fastened to a pole and projecting over the track. In this country they are almost universally placed over the centre of the track, but abroad they are sometimes placed on the side of the road, the trolley being so constructed as to make a side-bearing contact.

Underground Trolleys.— From the earliest application of electricity to railways, attempts were made to do away with the overhead wires used in the ordinary trolley systems. Conduits having a slot through which a current-collecting device could pass were placed beside the tracks or between the rails; conductors were placed in these conduits and the collecting devices on the cars were made to bear against the conductors. At first the conduits were not large enough, not enough space was given for insulation, and the results were unsatisfactory. The first successful system to be installed was a tramway at Budapest, designed by the Siemens Company. Here the conduit was on the side of the track, the tram rail forming part of the slot. The conductor was supported from below by insulators and the system was constructed on a larger scale than had been previously employed — the details were carefully worked out and the road has operated successfully from the time of its installation. In the meantime, in this country, the necessity of some such system in the cities of New York and Washington, where overhead wires were not permitted, had forced the different electrical companies to take up seriously the question of conduit construction, with the result that successful systems were worked out for both Washington and New York, the systems being practically the same. The slot in these systems is in the middle of track. The conduit is constructed as follows: Cast-iron yokes supporting the tramrail and slot rail are placed at intervals of five feet, the rails are attached to the yokes and the whole structure is blocked up in its proper position; then sheet steel is placed between the yokes, forming a tunnel of the proper dimensions, and concrete is packed around the yokes and the forms, supporting the structure in its proper position and forming a tunnel for the conductor rails. The steel forms are then taken out. The conductors are made of T-iron, held from above by porcelain insulators placed in cast-iron boxes along the track. The details of the different systems that have been installed vary, but the above is practically the standard type of construction. The current for the car is collected by means of what is known as the plow, which passes through the slot and has two cast-iron contact shoes held against the conductor rail by springs; the rail is supported on cross-rods on the car and has a wide limit of lateral motion. It is usual to place ducts beside the track, these ducts containing the feed wires that are connected at various intervals with the conducting rail.

The Generation and Distribution of Current.— In the earlier roads, and, in fact, in many of the roads now operated in this country, the current for the motors is obtained from direct-current machines, having a voltage of between 500 and 600 volts. These machines are, as a rule, compounded so that their voltage increases with an increase of load. There were two reasons for this: One is that the increased voltage compensates to a certain extent for the loss of voltage in the distributing system; the other, and most important reason, is that the strengthening of the field prevents the sparking that might otherwise be caused by the armature reactions. It is the custom to ground the negative side of the machines and connect the trolley wires through what is called «feed wires» to the positive brushes. These feed wires are carried along the line, connected at intervals to the trolley wires, it being usually the custom to divide the road into sections and feed the different sections from different feed wires. At the voltage which has been adopted as the standard — that is, from 500 to 600 volts — the economical distribution when the service is heavy is limited, and if a direct-current system is to be employed for a large area, a number of stations must be installed. For this reason, when the distances are great, it is sometimes necessary to employ a high potential alternating system, reducing it to a 500-volt continuous-current system at centres of distribution called sub-stations. On interurban lines, for instance, where the distances are great compared with the number of units in operation, this method becomes imperative, as otherwise the variations of load on the central station would be excessive, and the cost of power would be practically prohibitive. This method of operation may be described as follows: The central station, located at some point where the greatest economy of operation can be obtained, generates alternating currents at a high potential; these alternating currents are taken to the sub-stations, situated at reasonable distances from one another along the line, and are there changed to alternating currents of lower potential by means of transformers and then converted into direct currents of the proper potential by means of rotary converters. In this way a large area can be supplied from one central station and a comparatively large number of units can be operated at one time from this station, thus giving conditions of maximum economy. On the sub-stations themselves, there is, of course, a fluctuating load and it is the custom to install storage batteries in connection with the rotary converters to equalize the load; the battery storing energy when the load is light and giving it out when the load is heavy.

The Return Circuit and Electrolysis.— In most of the overhead traction systems, the current passing through the motors goes through the wheels of the car to the rails, and then returns to the station, «bus bars» finally appearing at the negative brushes of the dynamos. When a system is operated in this way, the rails are bonded — that is, two adjacent rails are connected by conductors securely attached to the rails and giving a low resistance to the electric current. If the bonding is good, a considerable part of the current passes along the rails while a small portion strays through the earth to other conductors, such as water pipes and gas mains, using these as a return conductor. If the bonding is bad, however, a considerable portion of the return current is carried by the underground pipes, causing them at times serious injury. For this reason, and also because of the fact that low conductivity in a rail return causes loss of energy, it is of importance that the bonding of the rails should be as thoroughly perfected as possible; it should also be carefully inspected at intervals, as the bonds are liable to break and produce a high resistance between the adjoining rails, thus diverting a considerable amount of current to the underground pipes. The matter of the electrolysis of underground metallic structures received little attention during the first two or three years of electric railroad development; the effect, however, naturally increased with time and the development of the systems until the serious damage that occurred became evident, and means for preventing it was sought. These means, as a rule, consisted in connecting different points of the rail circuit to the negative bus-bars of the station, by return feeders, and in making metallic contacts between the rail and pipes at points where the current was leaving the pipes; also in metallically connecting the pipes near the station with the negative bus-bars. No electrolytic damages is done when the current leaves the pipe through a metallic conductor; it is only when the current passes from the pipe through an electrolyte, such as is furnished by moist soil, that corrosion takes place. In some places, the joints of the pipes have been insulated to prevent the current from passing through them and this is perhaps the most efficient means of avoiding electrolytic troubles.

Alternating-current Motors.— The most important drawbacks of the induction motor are these: In the first place the motor has practically the same characteristics as a direct-current shunt motor and, therefore, does not afford the variation of speed with load that is one of the most important and valuable features of a series motor. In the second place three circuits are necessary to operate the machine and while the track can be used for one of these circuits, the necessity of two wires over each track, the wires having a considerable difference of potential, makes the practical operation of such a traction system difficult. Numerous systems have been devised for regulating these motors, but they are either complicated or inefficient and it is the opinion of the writer that induction motors will not be used for railroad work except under special conditions. The only advantage such a system offers is the high potential that can be used and this advantage is neutralized by the fact that the three conductors necessary make high potentials practically unavailable. Electrification offers a wonderful opportunity for saving in capital expenditure, where expanding demands new facilities which by other means would be inordinately expensive to provide. The higher sustained speeds of electrically-hauled trains on heavy grades offers an irresistible opportunity to expedite traffic and the flexibility of make-up and movement of multiple-unit suburban trains is a most valuable consideration. The fact that electricity as a source of railroad motive power offers the only possible connecting link between the waterfall and the locomotive gives it an unique position, analogous to that of alternating current in the general power distribution field. It is more difficult to *prove out* the economy of electric operation on this basis, but it is certainly sound over-all conservation to use to the limit a form of motive power that cuts down materially the rate at which the supplies of coal and fuel oil are being depleted.

During the last few years the new cars have been made considerably larger and hence the propulsion equipment has become proportionately more powerful than that formerly provided. The latest motors are specified to perform any service, on cars weighing 75 tons loaded, that is now being performed by the motors on the original 58-ton cars and it is required also that they shall operate satisfactorily on trains made up indiscriminately of the old and new types of cars. These motors are provided with tapped field commutating poles and self-ventilation. They operate normally at 600 volts direct current but are capable of successful operation at voltage up to 750. Space restrictions have had a marked influence on the design, owing to the use of clasp brakes and the desire to utilize standard electrical construction and to this end the gear face has been reduced to four and one-half inches in place of the five-inch face that would ordinarily have been used. Acceleration is accomplished either automatically or by hand, the former being under control of the current-limit relay on each car and there are 10 notches for forward running and six for reverse, these including the running positions made available by the field control as well as the customary intermediate running points.

In some of the single-phase locomotives of recent construction spur gears and coupling rods have been adopted for transmitting the power from the motor to the driving axles. Each truck is provided with two motors geared to a common intermediate shaft which is connected to the driving wheels by means of the coupling rods. The latter are arranged one on each side of the locomotive with an angular displacement of 90 degrees. The pinions on the motor shaft are fitted with springs to give circumferential flexibility. This arrangement is adopted to equalize the tooth pressures on the two pinions and to compensate for the sudden alterations of tongue chiefly due to the coupling rod drive with its changing reciprocating forces. Two strongly constructed centre pins supported from the trucks take the weight of the locomotive body and the electrical equipment. The control switches with their operating apparatus are mounted together with the transformer so that the whole forms a complete unit which can be installed or removed bodily through an opening in the roof. The two motors of each pair are connected in series, while the two pairs are in parallel with one another.

Electric locomotives are now generally considered in two groups, regardless of system of current supply, namely, the powerful machines which are used in heavy electrifications on the main lines of important steam roads and the lighter locomotives which find their field of application in less conspicuous duty in the electrified zones of steam roads and in handling freight cars on interurban lines. The former locomotives are of special designs, each railroad system having its own requirements. The design of the lighter machines tends more to standardization. Standard interurban freight locomotives are usually of the *steeple* type which is preferable to the box type in appearance and is free from compressor noise.

1 Self-Reversible Tractor carrying its own Plows
2 Tractors hauling 12-disc Plows and Spike-toothed Harrow Trailing

1 Tractor hauling Hay Wagon and Loader

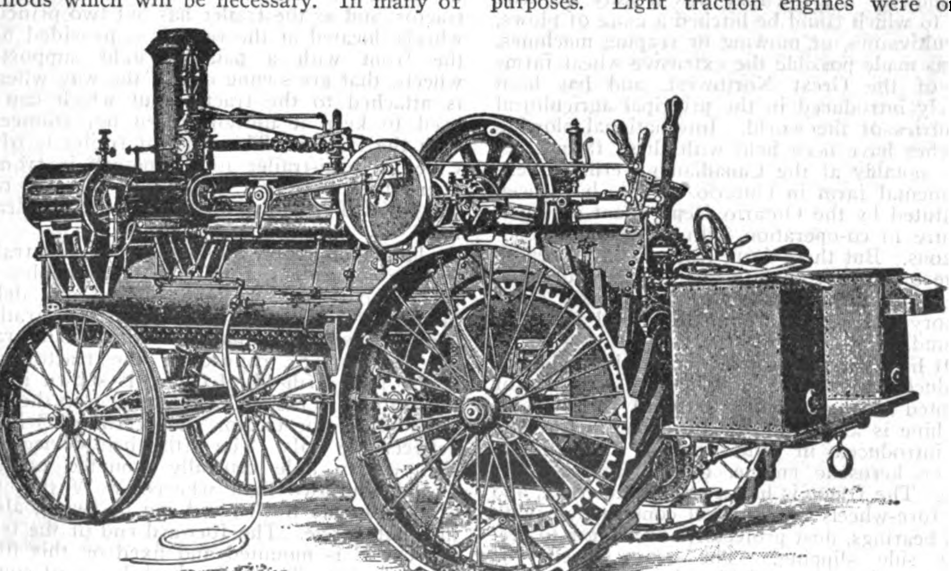
2 Tractors hauling Reapers and Binders

Design features introduced to ensure reliability and low maintenance cost include particularly (1) Form-wound armature coils, with special insulation in the ends of the slots; (2) Strap-wound field coils securely fastened and held against vibration; (3) Substantial brush-holder design and construction; (4) Mica insulated, undercut commutations; (5) Bearings of ample size with oil-gauging pockets, lubricated by oil drawn up and filtered through waste; (6) Two-point gear case suspension. The unit switch control has proved itself capable of handling the heavy currents encountered and also to withstand the bumps to which the locomotives are subjected, particularly in switching work, low-speed, drag-freight service or main-line service. In this control the various main circuit connections are made by unit switches, actuated by compressed air taken from the air-brake system; the admission of air to the switch cylinders being controlled by magnet valves, which valves are operated by current from a control circuit through a train line from the master controller. Current from this control circuit is tapped from points on the control resister which is connected between trolley and ground, or may be supplied by a storage battery.

In late years the solution of the electric railway problems has become more difficult. The automobile has become a most serious competitor; at this time more than 6,000,000 pleasure cars are licensed. The automobile has not only decreased riding upon the trolley cars during business hours, but it has deprived the railway of practically all of its pleasure riding. The entire economic basis of the industry has been undermined and if the business is to survive it must be a radically different business in the future than it is at the present time It must, in the first place, secure prompt and adequate relief by a sufficient increase in revenues to enable it to function as a public utility; for a rejuvenation of credit is essential to carrying through the radical readjustment in operating methods which will be necessary. In many of the smaller cities, the companies must turn to one-man cars, permitting more frequent service with reduced operating cost. In the larger cities the companies and the public must face the necessity of abandoning the theory of a flat five-cent fare covering the entire city area and of charging the passenger according to the distance which he rides. See AMERICAN STREET RAILWAYS; RAILWAYS, STREET.

EDWARD S. FARROW,
Consulting Military and Civil Engineer.

TRACTION ENGINE, an engine designed for drawing loads on ordinary roads or across country, and thus distinguished from the locomotive which hauls loads over steel or iron rails. The traction engine is designed to withstand severe jolts and to climb gradients of at least 1 in 10 and on a surface which sinks somewhat beneath the weight of the engine, thus presenting a continual slope upwards in front of the wheels. The speed seldom exceeds eight miles an hour and consequently it is usual to reduce the speed of the driving-wheels from that of the engine shaft by intermediate gearing. Usually attached to the main axle is a winding drum, by which heavy loads may be drawn up bad hills on a wire rope, the engine having previously ascended, light, to the top. A heavy fly-wheel and a high-speed governor are provided. The driving-wheels of a traction engine have tires or treads of great breadth to distribute the weight of the boiler and engine over a large area of yielding roadway. The tires are also usually corrugated or roughened to give adhesion. A very efficient means of steering is always provided in the traction engine to enable it to make the sharp turns required in ordinary roads, and it is furthermore usually so designed that by throwing out the intermediate gearing from connection with the traction-wheels, the steam-engine proper can be used as an agricultural engine for threshing, milling, pumping and other similar purposes. Light traction engines were once



Common Form of Traction Egnine.

favorites in drawing plows but have been displaced by the tractor of the internal-combustion engine type, although these are really traction engines. It is, however, usual to limit this term to the older type of land engine propelled by steam. This type appears to hold its place in America for hauling threshing machines from place to place and for driving them. In roadless countries, such as parts of Australia, Africa, etc., a heavy type of traction engine is employed to haul trains of wagons, as well as to act as portable engines for providing power for threshing machines etc. Engines designed for threshing outfits are supplied with fire-boxes capable of burning wood, straw and refuse fuel. Since the opening years of the present century the steam traction engine has been displaced to a very great extent by tractors and engines of the internal combustion type. (See TRACTOR). Consult Maggard, James H., 'The Traction Engine: Its Use and Abuse' (3d ed., Philadelphia 1915).

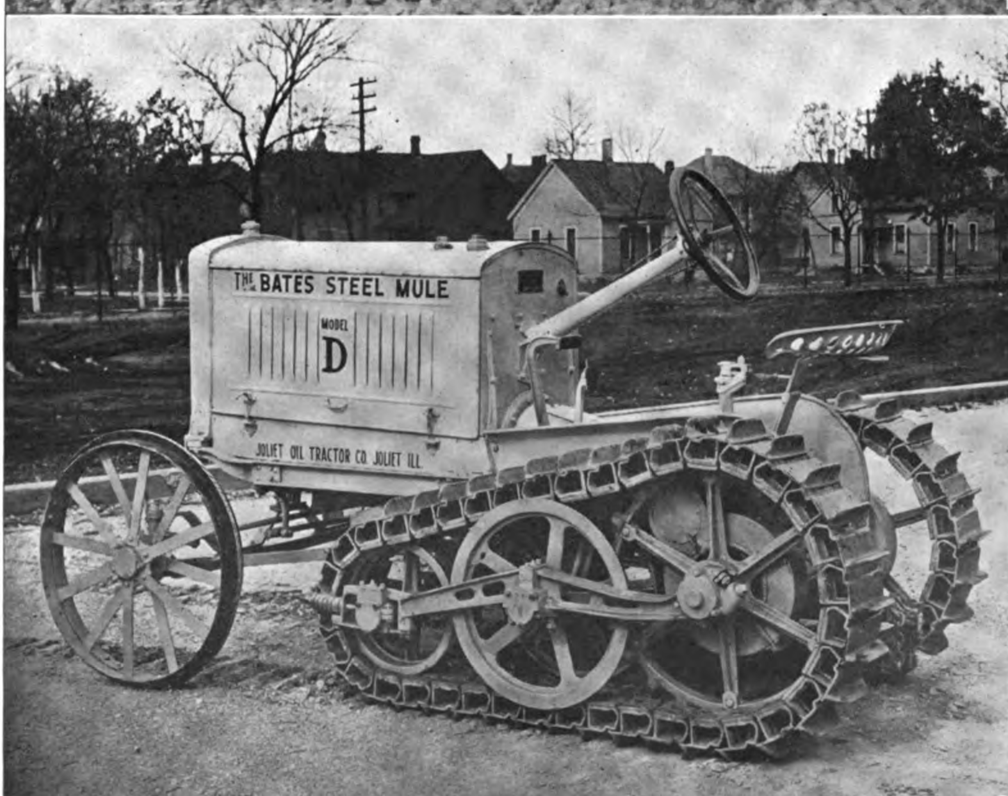
TRACTOR, a machine that draws a load, especially a power-engine mounted on wheels for traveling on roads or rough ground and hauling wagons, trailers, plows, cultivators or the like; a traction-engine. The locomotive (q.v.) was the first common form of tractor, but does not bear the name, and by common consent the term has been confined mainly to road-engines that do not operate on a track or ride on rails. The word tractor began to be used when steam plowing became general. For this purpose a road-engine was developed with massive wheels, having broad metal tires that would not sink readily in soft soil, and to give them greater grip on the ground, or tractor capacity, cross-pieces were fixed on the rims, so as to resist slipping when there was hard pulling. This engine was provided with a long, horizontal boiler, an upright smokestack and many of the conveniences of a locomotive. At the rear was usually a drawbar, to which could be hitched a gang of plows, or cultivators, or mowing or reaping machines. It has made possible the extensive wheat farming of the Great Northwest, and has been largely introduced in the principal agricultural countries of the world. International plowing matches have been held with these farm tractors, notably at the Canadian government experimental farm in Ontario. These have been instituted by the Ontario Department of Agriculture in co-operation with Plowmen's Associations. But these farm tractors have been so large and costly that their use was prohibited on small farms, and they have been satisfactory only on approximately level areas of ground.

It has remained for Henry Ford and Son to produce a small and inexpensive tractor adapted to the use of the small farm. This machine is known as the Fordson tractor, and as introduced in 1918 carried a 22 horsepower kerosene engine, of the four-cylinder type. The frame is like a small auto-truck, and the fore-wheels are of steel construction, with ball bearings, dust protector, and flanges to prevent side slipping. The rear wheels — 42 inches in diameter and 12 inches wide — are the drivers, and carry most of the weight; the gripping flanges of these are of angle-steel, set at an angle of 45 degrees. The driver's seat is between the driving wheels, and the method of control is very similar to that of a light autotruck. A bevel-pinion and sector are connected with the steering wheel, and entirely enclosed and lubricated by oil splash. Directly under this is the throttle lever, the spark lever being mounted on the dash. The distance between the wheels, constituting the tread, is but 38 inches, and the machine can turn a complete circle within 21 feet.

The ordinary plowing speed is two and three-quarters miles an hour, with a low speed of two and one-half miles an hour, the drawbar pull being 1,800 pounds and 2,500 pounds, respectively. When traveling or doing light work, a speed of six and three-quarters miles an hour is available. Fairly good ground can be plowed at the rate of about three-quarters of an acre an hour, varying, of course, with conditions. A little less than three gallons of kerosene per acre is a fair average consumption. With fuel and water tanks full the machine weighs 2,700 pounds.

Automobile Tractors.— As soon as the modern auto-truck was perfected and began to have a considerable sale, it became apparent that it was a convenience to separate the truck into two or more parts, one being a tractor and the others trailers. Many of the manufacturers of auto-trucks build tractors on the same general lines as their trucks, but instead of providing them with a rear body for carrying a load, there is simply space for attaching a «fifth-wheel» device, or else a draw-bar, to which a trailing car can be easily attached. A typical form of these is shown in the illustration, the tractor having four low heavy wheels, with radiator, motor and cab in front, and the rear of the chassis clear for supporting a fifth-wheel or turntable device, on which the forward end of a trailing car may be supported and swiveled. About 40 per cent of the weight of the trailer is designed to be carried on the tractor, and as the trailer has but two principal wheels, located at the rear, it is provided near the front with a pair of light supporting wheels, that are swung out of the way when it is attached to the tractor, but which can be used to keep it upright when not connected with the tractor. This type of trailer is often called a semi-trailer to distinguish it from a four-wheeled trailer, that bears all its own weight, and is pulled by some form of drawbar.

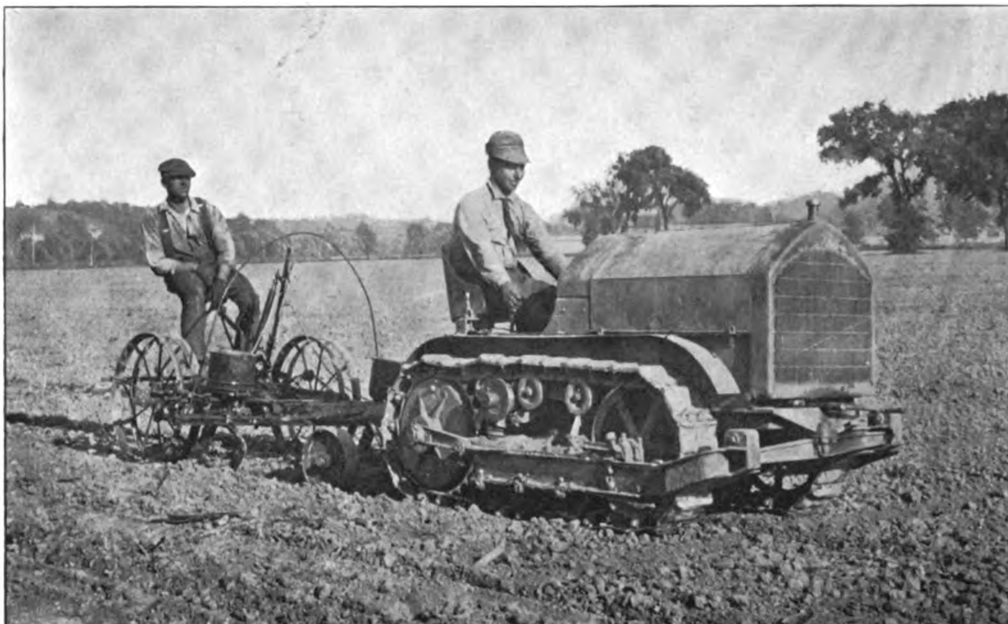
The combination of auto-tractor and trailer is very convenient, for it not only enables the tractor to deposit its load without any delay, but it can be used to haul all sorts of trailing cars, and often a number of them in a train. The method of connecting the tractor and trailer by a fifth-wheel device is shown in the illustration. Tracks T are mounted on the rear frame F of the tractor, and a swivel S is set between the rails. The fifth-wheel device consists of an axle centrally mounted on this swivel, and two light wheels W W that run around on the tracks, and can be swung about in a half circle. The forward end of the trailing car C is mounted and fixed on this fifth-wheel device. The fifth-wheel device of course takes its name from the fifth wheel on the front axle of an ordinary wagon, though it



1 Caterpillar Tractor hauling a Three-gang Plow

2 Caterpillar Tractor, especially effective on soft ground

TRACTORS



1 Caterpillar Tractor for farm work

2 Caterpillar Tractor for army work

has been developed into a mechanism that is much more than a wheel. Some manufacturers use a swiveling pair of bolsters instead of this fifth-wheel device. When a trailer is loaded ready to start, the tractor is backed up to it, and hitched on by simply guiding the two small wheels of the fifth-wheel device up the tracks; or, if an automatic coupler is used, the method of connecting may be very similar to that used in coupling railway cars. It is necessary to provide trailers with brakes, else they might create trouble in going down hill, and these have to be connected with the tractor, so as to be operable in unison with the brakes when set by the driver. The connection between tractor and trailer must also be such as to permit a rocking motion, so that when passing over uneven roads all the wheels shall travel on the road without straining the framework.

Military Tractors.— The military «tank» which attained fame in the World War was based on a peculiar form of tractor designed to work in a rough country, as in logging operations, canal building, etc. The very heavy endless chains, bearing feet on each link, fitted these machines for the most arduous pulling work under the most trying conditions, and some military man among the British recognized their possibilities when armored, and the military «tank» was the result, introducing this type of machine to untold thousands who otherwise would never have heard of it. Though too slow of operation to compete with the ordinary tractor of auto-truck type, yet the tank-tractor has such superiority in marshy, stony and very rough ground, that it has obtained considerable use.

The Synmotor.— Another peculiar form of tractor that has been invented by a New Jersey genius is called the synmotor. It is an adaptation of the motor-cycle to agricultural traction. Instead of pneumatic tire wheels, this machine is provided with steel rims and angle grips, like the wheels of big farm tractors, and is designed to draw cultivators, seeders and small mechanism used in truck farming. Its peculiarity lies mainly in its being attached by a wire to a central post, around which it circles in reducing spirals. When started on a circle of ground it does its work automatically until the entire circle of 100 or more feet in diameter is plowed or cultivated, excepting a small portion in the centre. It operates in a four- to seven-foot swath, and uses gasoline fuel.

The drawing or pulling device of a ropeway or wireway is also termed a tractor. See MOTOR TRUCK; TANK.

TRACTOR, Caterpillar. A tractor employing, instead of the usual drive wheel, a flexible steel belt, or track, which supports the weight of the machine, even in very soft ground and gives it greatly increased tractive efficiency under all conditions. Invented by Benjamin Holt, of Stockton, Cal., about 1900, it was first used in the peaty soil of the San Joaquin delta, or «tule,» country. It is particularly adapted to cultivation of orchards or other plowed ground since there is no soil packing; to reclamation work in swampy land; to hauling where roads have not been established, as in desert, forest or in military operations; to climbing grades, since the track principle affords unusual pulling effort in proportion to weight, and to other extreme conditions. It is also used, of course, wherever ordinary tractors can be used and is often preferred because of absence of injury to pavements. «Caterpillar» is a trade-marked word properly applied only to the Holt tractor. Other tractors following the same general principle are referred to as «Crawlers,» «Creepers,» «Alligators,» «Centipedes,» «Tracklayers,» etc. See TANK.

TRACTOR ENGINE. See INTERNAL COMBUSTION ENGINE.

TRACTS FOR THE TIMES, a series of short essays or theological pamphlets published in Oxford between 1833 and 1841 by the leaders of the Oxford movement — Newman, Keble and Pusey. See TRACTARIANISM; OXFORD MOVEMENT.

TRACY, trā'sĭ, **Benjamin Franklin,** American lawyer and politician: b. Oswego, N. Y., 26 April 1830; d. 1915. He was admitted to the bar in 1851, was district attorney of Tioga County in 1853–59, helped to organize the Republican party in New York State and served in the legislature during 1861–62. At the opening of the Civil War he recruited two volunteer regiments in New York, the 109th and the 137th, and became colonel of the former. Later he was colonel of the 127th regiment of United States negro troops, and at the close of the war was brevetted brigadier-general of volunteers. As United States district attorney for the eastern district of New York, 1866–73, he drafted an internal revenue bill which more than trebled the United States revenue at a time when the huge war debt was being liquidated. In 1881–82 he served as judge of the Court of Appeals, and in 1889 became Secretary of the Navy in President Harrison's Cabinet. His term was marked by a large increase in the navy and the formation of a reserve naval militia. At the close of this service he resumed his law practice in New York. He was president of the commission that drafted the charter for Greater New York in 1895–96, under which he was the Republican candidate for mayor in 1897, but failed of election. In 1899 he was counsel for Venezuela in the boundary arbitration between that country and England.

TRACY, Joseph, American Congregational clergyman: b. Hartford, Vt., 3 Nov. 1794; d. Beverly, Mass., 24 March 1874. He was graduated at Dartmouth in 1814, ordained to the ministry, and was pastor of churches at West Thetford and West Fairlee in 1821–29. He edited the *Chronicle*, Windsor, Vt., for five years, the Boston *Recorder* for one year and then became president of the Massachusetts Colonization Society and of the American Colonization Society for Massachusetts, which positions he held until his death. He was associate editor of the *American Theological Review* for many years and published 'Three Last Things' (1839); 'The Great Awakening, a History of the Revival of Religion in the Time of Edwards and Whitefield' (1842); and 'A Memorial of the Semi-centennial Anniversary of the American Colonization Society' (1867).

TRADE. See COMMERCE; IMPORTS AND EXPORTS.

TRADE, Acts of. See ACTS OF TRADE; GREAT BRITAIN — NAVIGATION ACT.

TRADE, Board of. (1) In the United States a body of men selected from among the business men of a city, and appointed to represent and act for the whole business community in advancing and protecting their interests. (2) A similar body acting for a trade or industry, usually for the regulation of trade abuses. (3) In England, a permanent committee of the Privy Council, presided over by a member of the Cabinet, and divided into seven departments, each having its separate staff. It controls the issuing of patents, registering of joint-stock companies, handles trade insurance, settles disputes, etc. The British Board of Trade conducted highly useful work during the great World War, exchanging commercial intelligence, and assisting manufacturers and merchants in the unusual problems confronting them.

TRADE ASSOCIATIONS, business organizations composed of the individuals, firms and corporations engaged in a trade or industry, formed and operated to deal with those things in which the membership have a community of interest, as wage scales, uniform rules and measures, guarding of legislative interests, maintaining prices, exchanging of information as to credits of customers, etc. These associations in the United States developed mainly after 1870, largely as a result of the growth and activity of the trade unions. (See UNIONISM). The demands by workmen for better pay and conditions were generally resisted, and employers met and began to organize against their employees. Before such meetings the proprietors in a particular trade rarely had any personal acquaintance, knowing each other only by name, and usually having a poor opinion of each other, because of sharp competition and business rivalry. Brought into contact over labor difficulties, their views as to each other changed; they learned to respect their competitors, and warm friendships sometimes developed between them. They began to talk with each other about trade problems, and soon saw the wisdom of combined action in securing trade reforms. Their anti-union associations took on a broader scope; they engaged secretaries and business managers, and began to do business in those things which were for the common interest and benefit of the trade. So came into being the American Newspaper Publishers' Association, the National Association of Stove Manufacturers, the Association of Wool Manufacturers, the Typothetæ (q.v.), The National Erectors' Association, the Coal Operators' Association, the Photo-Engravers' Association, National Metal Trades Association, National Founders' Association and hundreds of others. As time went on, each of these associations tended to enlarge its scope and sometimes several organizations were formed in one trade, to care for different branches of the work. For instance, in New York City, the Typothetæ, the oldest organization among employing printers, concerns itself largely with exchanging information as to costs, bookkeeping, preserving fair competition, watching credits, etc. The Printers' League handles all labor difficulties, makes agreements with the unions, settles disputes as to shop rules and the like. The Master Printers' Association concerns itself with the well-being of the smaller printing offices, the job printers, insists on uniform treatment by paper jobbers, the charging of a fair profit on engraving, binding, etc., reports on customers who are slow pay, etc. In most cities, however, one local organization serves a trade wholly, and no need is felt for two or three to look after various branches of work. It is practically true that in every large city there is a trade organization in every trade represented by a considerable number of houses. These conditions have naturally led to combinations to keep up prices, and the public has been jealous at times of certain organizations, which they classed as a trust in certain trades and industries. At times the suspicion of taking unfair advantage of the public was well founded, and at other times the members of a trade association have only sought fair protection from competition that was ruinous and not advantageous to the community. Where the trade organizations have gone too far, and used their power of co-operation to push prices above a fair level, there has usually been a reaction; either district attorneys have brought criminal suits charging «combination in restraint of trade,» and caused the dissolving of trade associations, or else the increased prices have brought new firms into the field, that did not belong to the association, and these have undersold, and brought down the level of prices to a basis of keen competition. Of late years there is a tendency in the United States for the large trade organizations to work together for business reforms. They call upon each other for assistance in securing needed legislation, and they have formed a National Association of Manufacturers, whose influence is very powerful. See TRADE, BOARD OF; CHAMBERS OF COMMERCE.

TRADE DOLLAR, a former coin of the United States, containing 378 troy grains of silver and 42 troy grains of alloy. Trade dollars, issued under Act of Congress 12 Feb. 1873, were legal tender to the amount of $5. Those issued under the Act 22 July 1876 possessed no legal tender power. They were intended for trade with countries doing business on a silver basis. As silver depreciated in value the trade dollar depreciated, and speculators bought them abroad at 80 or 90 cents and circulated them in the United States at face value. This was easy because specie payment had just been resumed by the government in 1875, and the public liked the silver. When the lower value was generally understood, and they continued to fall in price, they were objected to and gradually disappeared from circulation.

TRADE-MARKS. Certain marks or inscriptions set on manufactured goods for the purpose of establishing the identity of their manufacture or selection. An examination of the evolution and development of the trade-mark in the United States of America is substantially an examination of the evolution and development of the vast commerce of our country.

Definition.— A trade-mark is a mark or sign indicating the source or origin of the article to which it is affixed. Unlike a patent (q.v.) it is not a monopoly. In its very existence it evidences competition, and lays claim to a degree of superiority in such competition. A trade-mark may consist of a word or words, or of a symbol, design, device or picture; or it may be constituted by an original and distinctive shape or form of package in which the goods are packed or contained; or it may consist of a combination of some or all of these elements; but in whatever form the trade-mark appears on the market, its office is either to indicate the origin or source of manufacture of the article, or when used, as it may be, by the dealer who sells to the ultimate purchaser or consumer, but who does not manufacture or produce the article, it may then indicate selection or endorsement of the manufacture of the article bearing such dealer's mark.

Office of the Trade-mark.— Not only does the trade-mark indicate the source or origin of the goods to which it is attached, but it also performs the office of guaranteeing or assuring to the purchaser, whether he be an intermediate or an ultimate one, that the honest skill of the owner of the trade-mark, the good quality of the goods, the carefulness of selection, the purity of ingredients or correctness of weight or measure are to be found in the articles to which such mark is affixed. Further than this the protected and defended trade-mark builds up for the manufacturer to whom it belongs that following in the market which becomes immensely valuable in appraising the goodwill of such a business.

The Origin of the Trade-mark.— The introduction of the trade-mark into commercial use was natural, and when once effected rapidly became a trade necessity.

A chemist in the olden days prepared a mixture or lotion and recommended it to the customers of his shop, who found it efficacious. A shoemaker made shoes for his patrons which by reason of good quality and superior workmanship won favor for him among his patrons; so that these trades-people, pursuing their various lines of industry, not only retained their custom, but were recommended by their patrons to others, such customers becoming accustomed to resort to the shop of the one or the other of the tradesmen who supplied such wants, a habit which is known in law as the goodwill of a business.

So long as the customer of the chemist transacted his business face to face with him in the same old shop, or so long as the shoemaker measured his patrons and delivered his goods to them in person, so long was it unnecessary for such manufacturers to mark their wares.

Their customers and patrons obtained a personal delivery and needed no other assurance or guaranty as to the genuineness of the articles purchased by them; but after a while, some of these purchasers and users of these various articles removed to other localities, and would desire to continue to use the same lotion or wear the same shoes; and they would order the same directly, if they could, or through some agent middleman if they could not; and then in the latter case, to quiet any apprehension which such customers residing at a distance might feel regarding the genuineness of the articles delivered to them, the chemist would affix a label to the bottle or jar containing the lotion, which would bear his name and address; and the shoemaker would mark on some part of the shoe his name and address; after a while the producers of these various articles found that the mere use of their name and address. while constituting a good and sufficient indication of the origin of their products, was nevertheless subject to several matters of inconvenience; the first was that perchance many of the customers could not read; and the next was, that the use of the name of the manufacturer alone was attended by a legal difficulty, to wit, that while a man's name would constitute a most perfect trade-mark, yet any other man bearing the same name had an equal right to use it, provided he did so honestly and fairly, and if engaged in the same line of business, a trade confusion would naturally and often did arise, as witness the Brown Iron Bitters case.

Adoption of Symbols and Arbitrary Words.—To reach and remedy these difficulties, manufacturers then began to adopt and use symbols consisting of pictures or devices, at first simple in their nature, such as shields, stars, geometrical figures or representations of animals and the like; they also coined arbitrary and fanciful names, not descriptive of kind or origin, which were generally used in connection with the name and address of the manufacturer; and so it came to pass that symbols, devices and arbitrary designations or titles were slowly, gradually, but generally substituted in the place of the mere name and address of the manufacturer; the goods in due course of time became known by such marking; the marks, in turn, served to indicate origin, as well as to guarantee the peculiar excellence which the purchasers or consumers expected and had a right to find in their purchases with respect to quality, purity, measure or value.

So public usage has also often given an accidental meaning to a trade-mark, not at all contemplated originally; as witness the case in France, where a man named Jean Bardon manufactured cigarette paper, marking it with his initials, «J. B.,» which he separated by a lozenge, so that the mark appeared to be the word «JOB.» The public became accustomed to call for «JOB» paper, and that name was duly protected as a trade-mark, although it had never been intended to invent or use the word «JOB» in connection with Jean Bardon cigarette paper.

Requirements of a Valid Trade-mark.— Inasmuch as the markets of commerce are «markets overt» or «open markets,» it soon became evident that, in order to secure a trade-mark which would be unique, and the exclusive property of the person or firm originating and adopting it, such mark would of necessity have to be one which others did not have an equal right in law to use for the same class of merchandise; so that it became an established rule of construction of the law of trade-marks that no mark would be protected as the exclusive property of any one person which others had an equal right to use; as, for instance, a mark indicating quality, or a geographical mark, indicating that the goods bearing the mark were made or produced in a certain locality; or a mark which merely consisted of the statement of ingredients, or the generic or class title of the article; to be perfectly plain, every person living in New York, making hats or shoes, or other articles of commerce, would have the right to label and mark such articles as «New York Hats» or «New York Shoes» or the like; so every person would have the right to make the «Best Quality Hats» or the «Best Quality Shoes» or «Superior Hats» or «Superior Shoes» or the like.

Kinds of Trade-marks.— There are two distinct kinds of trade-marks, to wit, a mark consisting of a word or words, or a mark consisting of a symbol or picture.

The former kind may be designated as an «ear-mark,» and being mainly distinguished, when used, by its sound, it has been held by high authority that the use by another of a similar word, alone or in any form or combination, or in connection with any style of label or form of package, is unlawful, and would constitute an infringement upon the original mark.

The other kind of a mark, consisting of a symbol or picture, may be designated as an «eye-mark,» because it appeals to the sense of sight. To constitute an infringement upon such a mark, the defendant's mark must be of so close a resemblance as to be likely to mislead a purchaser using ordinary attention. There may be also an infringement upon important parts of a trade-mark, without the whole of the mark being copied. This will be restrained, because the law does not look for complete identity in the imitation trade-marks, but similarity will be held sufficient to warrant the interposition of a court of equity.

«Secondary Meaning» Phrases Protected. —In dismissing this branch of the subject, it may be stated that no mark which merely indicates an essential element or quality of the article to which it is applied can be exclusively appropriated as a trade-mark, subject, however, to one important qualification which has attended the evolution of the law of protecting industrial property in this country, and which was rendered necessary by the natural and proper desire on the part of our courts and judges to do equity and to protect the purchasing public.

The exception to which we refer is when a term, phrase, title or designation which is used in connection with a trade-mark acquires what is known as a «secondary meaning» in the market.

By this we mean that when a phrase, title or designation, which of itself could not be protected as a technical trade-mark, because primarily conceived and designed to merely invite trade or catch and engage public attention, becomes in time so identified and associated with the articles of merchandise to which it is affixed, that the public, on seeing it, at once recognizes that it stands for the goods to which the trade-mark proper is usually attached, even though that mark should be absent.

An illustration of this may be found in the case of a trade-mark for a certain medicine; the words «Candy Cathartic» are certainly descriptive, as fully descriptive as any words well can be; but they had been used to so large an extent and were so thoroughly advertised in connection with the medicine in question that it was shown that many purchasers instead of calling for the trade-marked name of the article would ask for «Candy Cathartic»; and, vice-versa, druggists handling the article so associated and identified the secondary phrase or title, «Candy Cathartic,» with the trade-mark proper that when «Candy Cathartic» was called for a box of the tablets would be promptly handed out. The court accordingly protected such descriptive phrase against use by a competing firm.

«Camel's Hair,» a purely descriptive term for belting, was protected after it had acquired a secondary meaning on the market, as applying to a particular make of belting. Likewise, «Stone» was upheld as a designation for ale, the name Stone being the name of the village in which the brewery was located, and which through such use had come to designate a particular product.

Likewise, a geographical name may acquire a secondary meaning, especially against infringers who do not reside in the same geographical territory or locality; as witness the fact that «Saint Louis» was protected as a mark for lager beer against brewers using the same title, but not doing business in the city of Saint Louis. The history of the «Durham» tobacco case may also be profitably considered, where Blackwell, the proprietor of «Durham» smoking tobacco, failed in his attempt to restrain another tobacco manufacturer of Durham from using such title in connection with tobacco, whereat certain Virginia tobacco manufacturers outside of Durham, becoming emboldened by the defeat of the Blackwell concern, began to use the title «Durham» in connection with their tobacco, but were promptly enjoined from so doing by the courts.

It by no means follows, however, that the defense of such trade-marks by the courts establishes the wisdom of their selection as such marks. On the contrary, they are to be avoided as leading to litigation more or less annoying and expensive. In the selection of a trade-mark every precaution should be taken against personal, geographic and descriptive names, and equally against such marks as in appearance or in sound as spoken shall simulate trade-marks already owned by others. An error in these respects, even though it escapes legal prosecution, may result in the partial or total waste of money spent in advertising, which, indeed, may redound as well to the advantage of a competitor as to one's self. Another point to be remembered in devising or selecting a trade-mark is that it should be simple and easily recognized. Few customers give keen and close observation to goods purchased, and the ultimate value of the goodwill of a manufacturing business may be largely dependent upon the instant and unqualified recognition of favorite brands.

The Doctrine of "Clean Hands."—Another and most important matter to be considered by the owner of trade-marks is in their correct use of their trade-mark.

The usual protection and relief sought against infringement and the invasion of trade-mark property is by means of a suit in equity brought to restrain the infringer from continuing to imitate or use the infringing mark, and for an accounting for damages; but as such a proceeding in equity is governed by well-settled principles of equity, one defense which has been very often successfully urged and raised to defeat any action on the part of the owner of a trade-mark is what is known as the defense of «unclean hands.»

It is a well-settled principle of equity that "he who enters a court of equity, seeking equity, must do equity, and come with clean hands."

In other words, a party will not be heard to complain of the wrongful acts of another as against himself, if that same party has been guilty of similar wrongful acts of fraud, misrepresentation or deceit against the purchasing public.

The United States Supreme Court in the celebrated and leading case of Manhattan Medicine Company against Wood, many years ago, laid down the doctrine that a party would find no relief in a court of equity as against an alleged wrongdoer if he himself were guilty of wrongdoing in using the mark to deceive the purchasing public.

Having this important fact in mind, it behooves trade-mark owners and users to be very careful in the use of their marks, labels and packages, and the following simple rules may well be observed for their protection and benefit.

No misstatements concerning the origin, quality or quantity of the articles to which the mark is attached should be used in connection with the labels, packages or accessories of the goods. So, also, if a trade-mark was not originally adopted by a party but was acquired by transfer or assignment, such fact must be distinctly announced on the labels or packages. The courts, however, will not countenance the transfer or assignment of a trade-mark except as a part of the transfer of the business which it has represented. The business cannot be transferred to one party and the trade-mark to another.

While the doctrine of "Unclean Hands" has been carried to a very great extent by the courts, it has been held in many cases that too strict an application of such a rule would lead to the destruction of valuable industrial property, and, at the same time, relegate the purchasing public to the tender mercies of false, fraudulent and infringing marks.

The courts have in many cases recognized the fact that where there is no vicious or wrongful intent on the part of a trade-mark owner, who is shown to conduct a legitimate and honest business, that slight lapses or immaterial misstatements, not persisted in or continued, and statements which are substantially true, although not entirely so, will be overlooked and not visited with the punishment of denying equitable relief to the trade-mark owner who is guilty of such infractions.

The understanding which the public has of certain trade customs or usages are also allowed to prevail; as witness the "Hennessy Brandy" cases, decided by the New York courts of appeals, where the defense was interposed that the plaintiff's bottles were not full or actual pints or quarts in size, and that, therefore, the owners of said trade-mark were guilty of inequity and misconduct; but the court held that inasmuch as such pints or quarts were known as "commercial" pints or quarts, and understood so to be by the purchasing public, that no fraud was either contemplated or had been committed, even though the bottles to which the mark was attached were not of full measure.

How Trade-mark Property is Acquired.— Property in a trade-mark is acquired by priority of adoption and continued use on the market. A mere announcement of an intention to adopt a certain title or symbol which is not followed or accompanied by use on the market does not confer any trade-mark rights. Moreover, the law requires that the trade-mark shall be in actual use in trade before application is made for its registry. The title to a mark may be lost by deliberate abandonment or the transfer to others of the title or goodwill of a business in which the mark has been used.

The person who adopts and first uses a certain distinguishing mark for his goods, becomes possessed with what is known as the common-law right of ownership thereof, and such right is an enforceable one, and will be protected by the courts of this country.

Patent Office Registration.— Trade-marks may be registered under the existing registration statutes only when the same are used in commerce with foreign nations, or among the several States or with Indian tribes. The provision for marks used among the several States is new and in force since 1 April 1905. Under this law marks exclusively used for 10 years preceding the passage of the law can be registered, irrespective of the prohibitions in the law, which would otherwise apply. Registration confers no greater property rights than are acquired under the common-law right of ownership, except that triple damages may be recovered in certain cases. Registration, however, does not create a right to a trade-mark; this is gained only by priority of adoption. The trade-mark thus signifies a public claim to such adoption and use; if it is not in accordance with the facts the registration may be canceled. Before registry a trade-mark is published 30 days in the *Official Gazette* of the Patent Office, during which period any person having good grounds for believing that its registration threatens his rights may oppose its registration. Besides the national law in the matter most of the States have trade-mark laws which protect the intrastate use of a trade-mark, a use which is not covered by the Federal law.

Assignment of Trade-marks.— Trade-marks may be assigned with the goodwill of the business in which they are used, or a transfer of the business itself; or they may descend by inheritance; but such an assignment must be recorded in the United States Patent Office within three months of its date or the goodwill thereof does not vest in the assignee any enforceable right or title. A trade-mark has no value or standing apart from the goodwill of the business of which it has been a part.

Partnership Marks.— Upon the dissolution of a partnership, either partner may thereafter continue to use the trade-marks of the partnership, unless the same are otherwise disposed of upon the dissolution, or where other contractual relations exist governing the future disposition of the same upon a dissolution.

Defenses.— In cases of infringement, actual deception by the infringer need not be proven. The likelihood of deception is sufficient to warrant the interposition of a court of equity. So it is no defense that the infringing article is superior in quality to the genuine, nor is the absence of intent to deceive a defense. Laches or delay in asserting rights are generally held to deprive the owner of the right to claim damages or obtain a preliminary injunction. Abandonment is also a good defense, but strict proof of an intention to abandon ownership is essential to the establishment of this latter defense.

Patented Articles.— Where a new trade-mark consisting of a word-symbol is affixed to a patented article, the right to use such name or title for such article will become public property upon the expiration of the letters patent, as was held in the «Castoria» and «Singer Sewing Machine» cases. Otherwise the monopoly enjoyed by the owner of a trade-mark is perpetual.

State Laws.— In many of the States, acts have been passed making it a criminal offense to refill or use again without the owner's consent bottles or other packages which have been registered under what are known as «Bottling Acts» or Trade-mark Registry Acts; so in many of the States the imitating or counterfeiting of trade-marks is made a criminal offense.

Labor Union Marks.— In many of the States labor unions or associations of working men are permitted to register their labels or trade-marks, indicating that the goods to which such labels or marks are affixed were manufactured by union labor, and such acts have been sustained as constitutional in most of the States.

Copyrighting of Labels.— New labels, not previously used, and containing some artistic or novel character of design, may be copyrighted in the United States Patent Office and will be protected for 30 years. But labels which merely describe an article, or only indicate size, number or weight, or are only the result of the application of the typesetter's art, are refused copyright entry.

Unfair Trade Competition.— An article on the subject of trade-marks and their protection in this country would at the present time be incomplete without some mention of the cognate subject of «Unfair Trade Competition.»

The evolution of the law of trade-marks in course of time satisfied the courts of this country that the mere enforcement of strictly technical trade-mark rights fell far short of the practical requirements and necessities of our commerce, inasmuch as the purchasing public was being constantly cheated and defrauded in having goods not of a genuine source of origin foisted upon them, while the owners of such genuine goods, as well as the purchasing public, were frequently left without redress or legal protection. To remedy this defect of the administration of justice, the restraining of unfair trade competition was applied to cases where technical trade-mark rights could not be enforced.

The essential difference between a case brought to restrain the infringement of a technical trade-mark, and to restrain a case of unfair trade competition, may be summarized as follows:

Both suits are brought to restrain a fraudulent act of the defendant; both proceed on the theory that a court of equity will protect the property rights of the owner of the trade-mark, and at the same time, guard the purchasing public against being deceived; but while in a case brought to restrain the infringement of a trade-mark, no proof of actual deception is now required, nor is any proof of damage to the owner of the imitated trade-mark required to enable him to recover, in a case of unfair trade competition the essence of maintaining the suit is in the establishing of the fraud practised by the defendant and the actual deception caused thereby upon the purchasing public. Probable deception is ranked with actual deception in constituting infringement. It is construed as an attempt to steal the goodwill of an established business.

It thus follows that in the extension of the principles of doing equity and according the fullest protection to the purchasing public, a man may even be restrained from using his own name in the transaction of his business, where such use is of a fraudulent character, calculated to breed trade confusion and designed to mislead and deceive the purchasing public, already accustomed to that name as connected with another line of merchandise.

History.— Trade-marks are of extreme antiquity, being found on bricks unearthed by explorers among Egyptian and Assyrian ruins, and upon Egyptian pottery dating back to 6000 B.C. Such marks have also been found on gold and silver ornaments and even upon carved jewels, and the containers used by the Roman pharmacists for their salves, creams and lotions. In more recent times historic mention of laws protecting workers in metals, smiths and armorers in such trade-marks as early as 1374. In the Middle Ages guilds of artisans in Germany, France and Italy compelled the use of trade-marks by their members as a protection to the purchaser as well as to the trade in general. Trade-mark protection in England did not begin until 1783, and it was not until 1838 that laws were passed which afforded really adequate protection. In the United States agitation for a trade-mark law began in 1791, but the Federal trade-mark law was not placed among the statutes until 1870. The present law bears date of 1905.

Trade-mark law in the United States has substantially been made during the past few decades; for the first reported American trade-mark case found in the books is that of Bell against Locke, decided by Chancellor Walworth in the Court of Chancery in the State of New York in January 1840. The following reported American trade-mark cases are desultory and sporadic until about the year 1870, when they became more numerous. Since that time, trade-mark litigation has vastly increased.

The Philosophy of the Law of Trade-marks.— The whole legal and underlying principle of the law embraced in this subject and its entire philosophy are founded upon the theory of securing honest trade and fair trade in the commerce of our national markets, and the doing of strict justice between man and man, while protecting the extremely valuable property rights which are at the present time found to exist in the transaction of modern business, both in the ability to enjoy unmolested and secure from invasion the marks of commerce, as well as to retain the goodwill of the business in which they are used. In brief, no one has or can have the right to sell his goods as ostensibly the product of another who has built up a goodwill by pronounced excellence of his products.

Equity has been poetically termed the «flower of justice»; and equity, with its long arm, and with the acute conscience of the court, is able to prevent and remedy acts of injustice, where the law itself would otherwise prove powerless and futile. See PATENTS.

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MORRIS S. WISE,
Editor of the 'Trade-Mark Record,' New York.

TRADE AND TECHNICAL PRESS, American. The principal function of the trade and technical publication is the advancement of the commercial, industrial, professional, scientific or other interest, which they represent, by keeping the reader informed as to the prevailing conditions of his trade throughout the country, and even the entire world. Thus a well-edited, broad-minded, accurate and progressive trade journal will exert a great influence toward welding together the separate units of each great profession, trade or industry into one vast community of interest. The general newspaper and the trade journal differ in the fact that the former appeals to the whole public, whereas the latter caters to a smaller class of professional, commercial, technical or scientific readers, giving within its compass only such knowledge as pertains to its special field.

These organs, of which every great trade in the country has its own, bring to the attention of those interested any invention or discovery which is, or in time may become, of great importance, but which to the general public would be of little or no interest; they present the conditions of the home and foreign markets by giving tables of quotations otherwise inaccessible to the trade; and gather all possible information which may be a guide to, or throw any light upon, future conditions. Improved processes or methods of manufacture and changes or improvements in other industries which would possibly have a bearing upon a certain trade; the many items of general interest to the lines with which they are concerned, and the public questions which vitally affect those interests; the almost innumerable changes taking place in the industrial world; all these, and more, are chronicled in every issue of the trade journal and discussed with a knowledge of detail, a grasp of the subject and fullness of treatment to be found nowhere else.

Such papers are of much importance to the trades they represent. Some are merely advertising sheets; some contain literary matter along with the special news; others are deeply scientific; yet each is conducted to subserve the interest of the respective trade. Of these papers some are published weekly; some semimonthly and others monthly; and a number of the financial papers, which may be considered as belonging to this class, are published daily. Some instances among trade journals have enjoyed remarkable and continued success, and have financially prospered far more than had been hoped, but the history of journalism is strewn with the wrecks of others whose existence was of such short duration that they did not pay for the original investment.

That the trade and technical journal may have the highest standard of editorial service and supervision, it is necessary that experts should be employed in the writing of articles, and none but the ablest men in each separate line should contribute, for the reader is generally an expert in the topic of which they treat, and any inaccuracy of statement or error of judgment is not only noticed, but is remembered. This tendency to inaccuracy or error is in a large measure lessened by the employment of a large corps of trained and skilful reporters who ascertain the tendencies of the market before they have become apparent, and also by having, in a great many instances, confidential relations with the leading minds of the trade. Thus a reputation is established, the paper becomes a power in its branch of industry and is quoted by all as an authority when discussing subjects of which it treats, and of which, in the nature of things, their knowledge is limited.

The trade journal also occupies an important position in the field of advertising, for the judicious advertiser selects the publication which is read by the class to which his merchandise will appeal, and this method is more economical and profitable to him than employing the ordinary newspapers which reach the general public and are not carefully consulted for technical matter. The vast number of advertisements which they publish in every issue, and the prices which they receive per line for such advertisements are astounding when the competition that exists for all these is considered. That it is profitable, however, to the advertiser, is plainly apparent from the enormous amount of advertising which each journal carries.

The *American Railway Journal*, of New York, first published in 1830, was the first paper which met the desires of one particular class of merchants. This was the pioneer of the specialty commercial journals, and it was for some time the only one of its kind, for though a few others had attempted to enter the field, their stay had been of short duration, and it was not until 1846 that one which still exists, was founded. This was the *Dry Goods Economist*, but though it began in the largest trade, it experienced much difficulty in attracting attention among either the buyers or sellers, and as conditions at that time were unfavorable to a journal of this character, it was not for a long time and only after a bitter struggle that it rested on firm ground.

These journals were soon afterward followed by those in the hardware and leather trades, known as the *Shoe and Leather Reporter* and *The Iron Age*, both of which experienced the same difficulties in gaining a foothold in the commercial world.

Meanwhile, the scientific field had been more successful as to the number of papers and periodicals published. The *American Journal of Science* was founded in New Haven, Conn., in 1818, by Professor Silliman, and the *Journal of the Franklin Institute,* in Philadelphia, in 1825. About 1820 a law periodical was founded in New York, but legal journals did not become common until nearly 50 years later. Medical journals soon sprang up in New York, Boston and Philadelphia, and are now to be found everywhere; a little later a journal was established treating of the drug trade. The *Scientific American* was founded in 1845 and since then many scientific or semi-scientific journals and various professional journals, not touching upon scientific subjects, have been started. By 1860 there were about 20 trade papers and 50 other technical papers; by 1872 this number had increased to 124 trade and 132 other technical papers, representing 41 different lines, in which religious, agricultural, educational and sporting journals were not included. See ADVERTISING; AMERICAN PUBLISHING; AMERICAN NEWSPAPERS; AMERICAN PRINTING TRADE; NEWSPAPERS; PERIODICALS; JOURNALISM; PRINTING; PRINTING PRESSES; BOOKS; ETC.

TRADE SCHOOLS. The differences in meaning between such words as vocational, industrial, manual training, technical, trade, part-time, co-operative, continuation, apprenticeship and corporation are not always understood and the terms are frequently used as if they were interchangeable, consequently brief definitions are necessary before the subject of «trade schools» can be satisfactorily treated.

Vocational education is an inclusive term for all forms of occupational training such as industrial, agricultural, commercial and household arts. A *vocational school* has for its controlling purpose the fitting of students for useful occupations. The pupil must have reached the age when work papers can be secured and the courses are below college grade. The aim of such a school is to supplement general education and not to take the place of it.

Industrial education is used in a broad as well as in a restricted sense. The term covers all education connected with the industries such as the industrial and household arts of the elementary and secondary schools, technical and trade instruction for industrial workers and training in engineering schools. The term *Industrial school* is used at times in America to indicate instruction of a primary order which gives pupils one or more branches of industry in order that habits of work and thrift shall be inculcated. This form of school is often used for reclaiming young offenders from evil habits, or for dependent and neglected children.

A manual training school offers activities of a more or less trade-like character with the idea of developing or educating the individual, that hand and mind may be trained together and each help the other. The aim is not to give a wage-earning vocation. The general education in these schools has usually little relation to the trades and is carried further than is necessary or possible for the ordinary apprentice. In some of the schools vocational elements are being introduced.

A technical school may be elementary in character or it may train engineers. The aim in both cases is to give theoretical and scientific knowledge connected with a chosen occupation. It prepares the overseer or superintendent rather than the apprentice or worker. In its simplest form such use of tools or apparatus is taught as will show the connection of theory with practice. Handwork is given to explain the science rather than to fit a student directly for a trade. The highest development of this type of school is found in the great technical institutions where both the application of art to industry and the most thorough scientific training are provided. The Massachusetts Institute of Technology and the great German and American textile schools are examples. The night technical classes so numerous in Europe and America are adding trade features in order to be especially useful to workers who are beyond 16 years of age, the aim being to provide instruction directly related to the employments. Many of the courses offered in the Young Men's Christian Associations are examples. In England the polytechnic schools offer training of this kind and public instruction in America is rapidly meeting this same need. Industrial and household arts, science, drawing and forms of industrial arithmetic and English are offered to enable ambitious older workers to get ahead in their trades.

A trade school may be advanced or preparatory in character. The first offers several years of training for full apprenticeship or for journeyman. The Williamson Free School of Mechanical Trades in Philadelphia is such a school. A preparatory trade school offers short courses of from three months to a year to workers (from 14 to 16 years of age) who are entering trade. The Manhattan Trade School for Girls in New York City is a school of this order. Trade schools are founded to teach a single trade such as watchmaker or tailoring or they may offer a number of occupations. The simplest form is a workshop where the manipulation of some trade is taught which requires the expert use of tools. This kind does little for the development of the worker. An all-day trade school, such as The Manhattan Trade School for Girls, aims to give a preparation which shall abolish the drudgery and waste of the regular workroom and supply an economic and vital instruction. Actual shop methods are followed in all of the trades, practice occupies most of the eight-hour day, and industrial art as related to each trade, hygiene and social, civic and industrial teaching start the student well equipped for wage-earning. *Part-time, co-operative and continuation schools* are used for trade instruction. The aim is to co-operate directly with the industry and train workers while they are wage-earning. The training may be given during the working day in the factory itself, the workers being paid and also given an education. Or the classes may be in a near-by school building, the students being allowed to leave their work for several hours per week. Salesmanship classes illustrate this form of training. Public instruction may be responsible for the teaching in both cases. Courses are given on subjects which are difficult to learn in the rush of the workroom. The experience which the worker is gaining in the trade itself is thus supplemented by instruction during the day for the younger workers and at night for the older ones. Technical courses, general education, science, drawing and design, business arithmetic and English are frequently given. These schools are being organized in many States as laws are enacted making it compulsory for employers to allow workers between 14 and 16 years of age to attend such schools during the day, for five or more hours per week, without loss of wage. Germany has done much to develop the continuation school during the day and at night. *Apprenticeship and corporation schools* have been organized by some of the railroads and great business enterprises for training their own employees. The work is of the part-time character and the workers are paid their full salaries. The aim is to increase the ability of the worker for his own sake as well as for the corporation.

This article deals with the trade school as it trains apprentices or journeymen, by day, or supplements their work in the regular trade by part-time classes by day or night. It deals with the wage-earner rather than with the overseer, superintendent and director. The textile and engineering schools and institutes of technology belong to the technical rather than the trade-school field and the instruction is usually of college grade. Some of them have special sections for apprentices, however. Many of the agricultural and mechanical colleges in the United States have trade departments but this work does not always lead to a degree. Drexel and Pratt institutes deal with trade courses in addition to their regular technical and normal aims. Regular all-day trade schools and part-time classes are not yet numerous all over the United States, therefore, other institutions are undertaking trade work to meet the demand of communities to help the workers.

Education for trade has for centuries received attention on the continent of Europe. Complete systems of industrial education have been developed in many countries, from the manual training of elementary and secondary education, through the trade and technical schools to higher engineering and scientific institutions. These schools are generally under government support and control. Within the last 50 years they have become increasingly important and are graduating competent workers for both men's and women's employments. The thoroughness of the courses in these continental schools has rightly given them a high reputation. The length of the trade courses abroad is from three to five years, a fact due to some extent to the demand of the trade unions for a long period of apprenticeship. The United States has some trade schools offering a like preparation. Conditions of artisan life with us are so different that the foreign type of trade school does not altogether meet our needs. The aim here has been rather to give the trade work in as short a time as possible, often in only a few months. This course is frequently accomplished by considerable drill in the theory as well as in the practice of the trade. The New York Trade School offers in its day classes three to four months' preparation in various building trades, a certificate of proficiency being issued on the completion of the work. European schools do not usually give such short courses as these. The Wilmerding School of Industrial Arts, for Building and Architectural Drafting, the Lick School of Mechanic Arts and the Lux School for Girls, all in San Francisco, and the Williamson School of Mechanical Trades in Philadelphia, correspond more nearly to the European model of thorough training for three or four years. In these schools the aim is to teach the trades with the science underlying them, together with thorough academic courses corresponding to our manual training high schools. The Manual Training High School of the United States surpasses anything of the kind abroad and is a distinctly American type. It does not aim, however, to give trade instruction, and hence the Williamson and the three California schools are not strictly manual training schools.

The value of trade schools has been recognized by foreign governments and they not only control, but also support or subsidize them. The war has temporarily interfered with this instruction in the warring countries, but as peace is established the work will continue. The trade schools already organized with us often began under private management but passed into public control, as with The Manhattan Trade School for Girls in New York and the Boston Trade School.

Germany has been foremost in developing trade instruction to supplement shop experience. The poverty of the workers there, as well as here, forces them early into the shops to earn a living. In order to help these workers to obtain better positions and better salaries, special day, evening or Sunday instruction has been arranged in the Continuation Schools (Fortbildungschulen). Each German state has made a study of the best way to help its different trade workers. These schools have been so satisfactory that they have not only developed all over the empire, but also in other countries. In Germany they are preferred to the all-day trade school. Belgium and France are renowned for their day trade schools; Austria and Hungary have unusually complete systems of trade instruction, and Switzerland and Italy also provide carefully for this class of education. For 35 years Russia has had trade schools to train the workmen in various fields. England's well-organized technical instruction includes trade work also.

Germany.

The awakening of Germany to the importance of training her wage-earners took place about the time of the Centenntial Exhibition in Philadelphia in 1876, which showed Germany's products to be distinctly inferior to those of other continental countries. The French Exposition of 1878 still further manifested the lack of art in Germany's manufactured goods, and a commission was appointed to investigate reasons and to suggest action. The result of the work of this commission is now seen in the systems of trade and technical schools which have been organized, and in the reputation which Germany now has for the application of science to industry. These schools have been great factors in this change. The German section in the Saint Louis Exposition of 1904 gave evidence that not only in the connection of science with, but also in the application of art to industry, that country has pushed to the front and now takes rank with or even excels those nations which have in the past controlled the industrial field. Germany has become thoroughly imbued with the idea that money devoted to trade instruction is wisely spent. The earnest study which she has given to the subject has shown her the problem in its complexity and difficulty. The solution has been varied to suit the needs of different localities and also of all classes of workers from the wage-earners of small skill to the directors of great industries. A satisfactory interrelation between workers, employers and schools has been the aim as well as social efficiency.

These schools have been founded and are supported in various ways: by the state, by the municipality, by the commune, by the trade guilds, by associations of workers and by private individuals. There is a marked tendency, however, for the governments of the German states to assume the entire control and administration. Small tuition fees are frequently charged. In some of the great technical or technological institutes gratuitous instruction is offered to apprentices, but a fee is required of those who wish to study for more advanced positions. The tuition fees, however, cover but a small part of the expenses.

Germany is giving attention to the training of apprentices for trade in many classes of institutions. Different sections of the republic vary in their way of meeting the problems. The following kinds of institutions are representative: Trade Continuation (Fortbildungschulen) and Industrial Continuation Schools (Gewerbliche Fortbildungschulen); Trade Schools (Fachschulen); Industrial Drawing Courses; large technical schools, with sections for apprentices; apprentice workshops (Lehrwerkstätten).

Of these the *Continuation Schools*, generally conducted by trade guilds, are by far the most popular for training the ordinary wage-earner. General education is compulsory in Germany up to the 14th year. After this time a majority of the children of the laboring class must begin to work to contribute to the support of their families. The continuation schools are formed to aid those of both sexes who are forced to work, their object being to supplement the trade in which the worker is daily employed. In industrial centres the curriculum is connected with the trades of the locality. In other sections, the character of the instruction may be general, commercial or even agricultural, as the need is felt. The courses deal more with the theoretical part of the work than with the actual manipulation of tools. The aim is to give such instruction as the worker cannot well get in the shops. It correlates with the daily shop work and thus aids the workers with the greatest economy, as the students are productively employed and expensive laboratories and shops are not necessary.

The beneficial effect of these continuation schools on the development of industry and on the condition of the working class has been felt so keenly that the imperial government has provided by law that employers must always permit their employees under 18 years of age to attend such schools. The state has made this education compulsory, it being felt that all employees should have an education which will enable them to better understand the nature of their trade. It often happens that these busy day workers are too tired when night comes to benefit by such instruction, and week day and Sunday classes have, therefore, been opened.

The continuation schools found in Prussia give instruction of a general character, but they emphasize drawing, bookkeeping and such branches as are likely to be of value to those engaged in shop or factory work. For girls they add embroidery, dressmaking, sewing, ironing, millinery, mending and cooking. In Bavaria the work of the industrial continuation schools is so specialized for individual trades or groups of trades that they are really trade continuation schools. Dr. Kerschensteiner, the schulrat of Munich, has been a force in developing continuation and trade schools in Munich and throughout Bavaria. His aim is always to make the students understand the materials on which they are working and to develop in them thought and wise action. It is said that 56 trades are taught in the schools there.

The trade continuation and trade schools proper usually differ from the industrial continuation school in giving more specialized trade instruction. An illustration of continuation work for boys is the Artisan School, No. 1, in Berlin. The aim is to "give to apprentices and workmen, especially during their leisure hours, a knowledge of drawing and the applied sciences and arts which concern their respective trades and which serve as the necessary complement to their shop practice." All of the drawing, mathematics and sciences are specialized in separate courses directly adapted to some trade. The hours of instruction are in the afternoon and evening of week days and on Sunday morning. All-day courses in trades are also given at this school.

Trade Schools with all-day work in a single trade are numerous, but are not always largely attended. Schools of watchmaking, basketmaking, cabinetmaking, horseshoeing, toymaking and other trades have been opened in response to local needs. The following is a partial list of the occupations provided for in the trade schools: Artistic darners, artificial flowermakers, bakers, barbers, basketmakers, blacksmiths, braziers, bookbinders, cabinetmakers, chimney sweeps, cooks, carpenters, confectioners, dressmakers, dyers, embroiderers (hand and machine), engravers, gardeners, garment makers, glaziers, goldsmiths, horseshoers, hairdressers, handsewers, ironworkers, joiners, knitters, lacemakers, leatherworkers, locksmiths, laundresses, masons, modelers, machinesewers, menders, milliners, paperhangers, painters, photographers, potters, printers, rugmakers, saddlers, spinners, stonecutters, stuccoworkers, strawplaiters, shoemakers, tinsmiths, tailors, trunkmakers, woodworkers and carvers, weavers, wickerworkers, watch- and clockmakers, wagonmakers, wheelwrights.

Trade work for girls in Germany is not as extensively developed as that for boys. The sentiment of the German people, that woman's place is in the home, has caused these institutions to combine strong housekeeping features with the trades. These housekeeping-trade schools are doing excellent work, but the trade continuation schools organized for women are of more general importance in training for definite trades. Most of these schools offer three distinct fields to women: (1) The commercial subjects, which prepare for clerkships or secretarial work, training stenographers, typewriters, etc.; (2) the domestic industries such as housekeeping, cookery, needlework, repairing and ironing, and (3) special trades for women, such as dressmaking, millinery, white work, art needlework, designing, bookbinding, composing and photography. In Berlin the nine municipal continuation schools for girls maintained by the city, and the Victoria Continuation School maintained by private funds, are typical schools of this character. They offer day as well as night work. The Women's Work Schools (Frauenarbeitsschulen) found in many cities, notably in Nuremberg, Bavaria and Reütlingen, Wurtemberg, are day trade schools as is also the Potsdam Trade School for Girls.

The Lette Society of Berlin has done much to foster trade instruction for girls. The aim of the society is the improving of the working class by (1) the removal of obstacles and prejudices in the way of female employment; (2) the fostering of commercial and industrial education; (3) the furnishing information for opportunities for learning trades and securing situations and help where existing institutions are inadequate; (4) the establishment of exchanges for the exhibition and sale of women's handwork; (5) the protection of women against harm, morally or otherwise, especially regarding lodging houses. This society has opened a number of different kinds of schools. The trade courses range from four to six months of all-day work.

The Schools and Courses of Industrial Drawing and Art have made their curricula so practical that they adapt themselves directly to the various trades. There are also, in many instances, workshops in connection with these art schools, in order that the student may have practical experience of the value of his designs and plans. The building and textile trades and such art industries as the making of jewelry, metal and wood working, engraving, gold and silversmithing, painting on glass and china, ornamental designing and decorative painting, are especially considered in these schools.

Elaborately developed systems of special *Technical Schools* provide for all grades of positions in the building and textile trades. They touch to a small degree the problem of training an apprentice. These great day schools have been very successful. Over 50 of them are to be found for the building trades, and Prussia alone has eight for the textile trades. There are three grades of labor in the building trades: (1) architects; (2) those who execute the architect's plans, and (3) the workmen. The evening continuation school sometimes provides for the lowest grade, and at other times the building trades school offers a special section. The textile trades have also three grades, and weaving workshops are provided for the apprentices, either in all-day work, or in evening and Sunday classes. In some of the textile schools women are admitted, the one at Aix-la-Chapelle offering an elaborate course of textile darning, the girls being paid wages according to the value of their work. The School of Textile Art in Plauen, Saxony, has also a department for women. Instruction in embroidery and the making of lingerie is given, the aim being to train superintendents of workrooms.

Apprentice Workshops are organized both in connection with public trade schools and as private institutions. They aim at a more comprehensive and systematic training than can be obtained in the ordinary shop. The Krupp Steel Works at Essen offer a complete course of apprenticeship.

Itinerant Trade Courses are also provided in such industries as weaving, garment cutting, embroidery, machine work, straw plaiting and bookkeeping. These courses have been beneficial in small towns where there are cottage industries.

The effort of organized labor to preserve handwork and the small trades has been of vast service in Germany in the development of trade schools. The various trade guilds have dealt carefully with the subject of apprenticeship and have been untiring in their efforts to have favorable conditions attend such instruction.

Belgium.

Education is not compulsory in Belgium, but the schools are well attended. The primary school is followed by an excellent system of trade education for both sexes. In many particulars the schools are similar to those in the neighboring countries, but they also present characteristic features. For boys the elementary trade schools are followed by superior trade and technical schools, and those again by the great technological institutions.

Trade-instruction is carried on in the industrial schools (écoles industrielles) and in the trade schools (écoles professionelles). The first gives theoretical instruction in industrial operations with practical courses in design. The second gives trade work combined with theoretical instruction, has all-day sessions, and is the trade school proper, although many of the écoles industrielles have trade sections.

Trade training of an elementary grade is given in the following institutions:— For boys: Industrial schools, trade schools, Saint Luke trade schools, apprentice shops, trade courses. For girls: Trade schools (including trade schools proper, trade and housekeeping schools, housekeeping and trade schools), trade courses, apprentice shops.

The length of the courses in the trade school proper is from three to five years. The trade schools for girls were organized before those for boys. They offer the most advanced form of trade education for girls. The industrial school is the largest and most important class of institution in Belgium for the training of young men. As these latter schools are supplementary to the trade and do not give regular trade instruction, and as their courses are given at hours when workmen can attend, they resemble the continuation schools of Germany. The number of these schools is rapidly increasing.

Trade instruction in Belgium is justly renowned for certain features: (1) The excellent system of economical administration and wise supervision; (2) the thoroughness of its instruction in general education applied to the various trades and also in the teaching of the trades; (3) the importance of art in all of the schools and the practical use made of it in designing in each of the trades; (4) the adaptation of all of the trade work to local needs.

The trade schools are with few exceptions under government control, although no general law governs their formation. Schools have been established by communes (écoles communales), by private individuals (écoles libres), and by provinces (écoles provinciales). Complete liberty of organization is allowed to local authorities or to private individuals, in order that the schools may be adapted to local needs. This freedom has made these schools really local institutions, conforming to no uniform model. A system of subsidizing them has been devised. A certain sum of money is voted annually for this purpose, and placed at the disposal of the minister of industry and labor. When the schools desire a portion of this appropriation they must submit a formal application, accompanied by details of their work which will enable the ministry to judge if the school should receive assistance.

The government exercises regular supervision over schools receiving the subsidy. Each year they must send to the ministry for approval of their accounts, their budgets for the ensuing year, and any changes in their organization or in their programs. The supervision of these schools is most efficient. An inspector-general of industrial and trade education is at the head, and under him is an expert corps of inspectors. Inspections are also made by such provincial or communal authorities as aid in the support. Religious bodies, industrial organization and private individuals also help these schools. Some of the schools give free instruction, some require an entrance fee, and others charge for tuition. Students who are too poor to pay for instruction or to attend even when it is free are aided in various ways.

The difference between a manual training and a trade course is very marked in Belgium. The trade schools may differ in characteristics, but they all keep strictly in view the fact that they are preparing students to earn a living in some particular branch of industry. Drawing and industrial design are at the base of all instruction for girls as well as for boys, and are taught with reference to their use in particular trades. A practical general education is also considered a necessary part of the instruction in the trade, and usually occupies the first half of the day. Libraries, museums, collections of scientific apparatus for demonstration, public exhibitions, and provision for traveling scholarships are means used to develop the highest efforts of students.

The provision made for teaching girls is very thorough. *The Trade Schools* proper (écoles professionnelles) have programs in theoretical as well as in practical work. There are at least 50 of them in the kingdom. The aim is to teach such trades as are open to girls, and at the same time to carry forward the regular school education. The trades taught are dressmaking and cutting, waistcoat- and corset-making, fine lingerie, millinery, artificial flower-making, industrial drawing and ornamentation, embroidery, designing for lace and embroidery, and painting on glass, china or silk. Commercial courses are also given. The general course, which is compulsory, includes the French and Flemish languages, arithmetic, history, geography, hygiene and domestic economy, writing, drawing, singing and gymnastics. The instruction is excellent and has been especially adapted to the trades and to the needs of women in their households. A high place is given to domestic economy in Belgium. Its full development is in the housekeeping schools (écoles ménagères), but some of it is required in the trade schools also. The trade courses for girls vary in different schools according to the needs. The length of the course is usually three or four years, but five years are sometimes required.

The pioneer trade school for girls in Belgium is the Bishoffsheim, 94 Rue de Marais, Brussels, established in 1865. The age of entrance is 12 years, and the length of the course is four years. The trade courses are numerous and well taught. The courses in drawing, including designing for lace embroidery and garment decoration, painting on glass, porcelain, china, fans and textiles, and the dressmaking and the artificial flowermaking are especially notable. The reception room at this school is decorated with fine examples of porcelain tiles and china painting, and the windows are of stained glass, this work all having been done by graduate students. The Communal Trade School for Girls on the Rue du Président, Brussels, is noted for the fact that each of the trade instructors is also the teacher of the course in design in connection with the trade. The course in embroidery and applied design is especially fine. Another Brussels communal school on the Rue du Poinçon, 26, noted for its dressmaking and commercial courses, and the Antwerp School, Rue des Architects, with its five-year courses in some of the trades, are also examples of the excellent professional training for girls in Belgium.

An advanced trade course of one year for dress designers, dressmakers and intending teachers in trade schools is given in Brussels, a study of the evolution of dress in all countries being a notable part of the work.

The Trade-Housekeeping Schools (écoles professionnelles-ménagères) and the housekeeping-trade schools (écoles ménagères-professionnelles) are also giving more or less time to trade work.

Apprentice Shops for teaching trade work to girls are not numerous, but are doing good work. They were opened in response to local needs rather than as a part of regular trade instruction. One of their distinguishing features is that the students after a time receive financial remuneration for their work. There are several of these schools, as the one at Bassenge for straw plaiting and straw-hatmaking; at Jemelle for lingerie and dressmaking; at Maldeghem for hand and machine embroidery and crochet work on tulle, and at Saint Trond for lacemaking.

The Industrial Schools (écoles industrielles) for boys are similar to the continuation schools of Germany. They are very numerous in all parts of the country and have been organized with reference to local needs. They teach a large number of technical subjects connected with the trades which the boys follow during the day. Some of these are also day trade schools and have advanced as well as elementary work. The school at Verviers is an example, the aim being to give a training to the workmen who are employed in the numerous industries in that city, including the departments of mechanics and construction, dyeing and weaving. The Industrial School at Tournay, which is one of the oldest and most important in Belgium, also partakes of the nature of a trade school. It has no shops of its own, but it has entered into contract with local manufacturers to direct the pupils' practical education. This is an excellent method of combining theoretical with practical instruction. The school gives its theoretical instruction in the early morning or in the late afternoon. The Industrial School of Morlanwelz has departments of mining, building construction, engineering, electricity, shop technology and mechanical drafting. The organization of the school population, the equipment, the excellence of the instruction and the ability of the teaching force make this school a power in the kingdom. The age of the students entering is from below 14 to over 20. The schools of Ghent, Seraing, Châtelet, Charleroi, La Louvière and many other cities are adapting themselves to local industrial conditions and are doing good work. Certain work in the industrial schools is also open to girls, but, with the exception of the commercial courses, they are not well attended.

The Trade School proper for boys is also well developed. Under this head are the day trade schools (for teaching actual trades), the trade continuation schools (for supplementing the day shop work), and the trade schools of fishing. Some of the day trade schools teach but one specific trade, while a number of trades are taught at other schools. An illustration of the first class is the Brussels Trade School of Tailoring. A four years' course is offered. The leading tailoring houses of the city show their interest in this school by contributing to its support, supplying it with order work and helping to place the graduates. The students pay a small entrance and tuition fee. They are paid a small sum for their work, and this money is placed in the state savings bank and given to the student when he completes his apprenticeship, but if he leaves the school before that time he loses the right to the money. The Gun Makers School at Liège for making arms was originally begun by the manufacturers but is now conducted by a committee composed of labor men, city officials and manufacturers. The school is open day and night.

The H. Nicaise Trade School of Metal- and Woodworking at Ghent is an illustration of the class of school offering instruction in several trades.

Jewelry work, chasing, upholstery, furnishing, printing and many other trades are taught in evening or in Sunday morning continuation classes. The trade schools for fishing are placed at the seaports.

The Saint Luke Trade Schools are similar both to the day trade school and to the trade continuation school. They aim particularly to train for artistic branches of the handicraft trades. They were established by the Roman Catholics. The school at Schaerbeek, Brussels, is an illustration of this class of trade school.

Apprenticeship Shops have been organized for weaving and stone cutting and are doing successful work.

France.

France began to plan and legislate for the training of her handworkers centuries ago. The forerunner of the trade school began in 1799, but the great development of the subject has been during the last quarter of a century, following the French Exposition of 1878. The number of such schools receiving help from the government increased from 48 in 1880 to 292 in 1904. France appreciates that her industrial success depends on the education of her workmen, hence the government takes a direct part in developing the system of trade instruction. Schools are provided to teach all grades of workers from the semi-skilled artisan in the ordinary trades to the engineer for the more advanced scientific and technical work. Trade training is always founded directly on primary education, design is considered fundamental and a large amount of shop work of a practical nature is given.

Manual apprenticeship schools have been organized to give boys instruction in their chosen industry or to fit them for the secondary technical schools. There are four *national trade schools* (écoles nationales professionnelles), situated at Armentières, Nantes, Vierzon and Voiron, and 32 *practical commercial and industrial schools* (écoles pratiques de commerce et d'industrie), 26 for boys which are situated in various parts of France, and six for girls at Boulogne-sur-Mer, Havre, Marseilles, Nantes, Rouen and Saint Etienne. In addition to these, the municipalities of important cities have established schools for the elementary teaching of trades, industries and arts. Religious bodies, societies, business enterprises and private individuals, encouraged by the success of the national and municipal schools, have likewise organized instruction for the improvement of the artisan.

Government control requires that the schools receiving subsidies should all conform to certain requirements. The *Practical School of Industry* at Saint Etienne (école pratique d'industrie) may be taken as a type of these institutions. The trades of weaving, modeling in wood, machine fitting, cabinetmaking, electricity and gunmaking are taught here. The work is on an elaborate scale, the course being four years in length. The first year is preparatory and completes the student's primary education while also giving him shop practice of various kinds to discover his aptitude for any trade. During the next three years he studies his trade practically and theoretically, and continues his general education which is closely adapted to his trade needs. Here, as in other schools, much emphasis is laid upon the study of art.

The greatest and most progressive system of *municipal trade schools* is in Paris. The Diderot School was the first one organized, having been established in 1872 for wood and metal work. The courses are three years in length, entrance being by examination. Practical work occupies the greater part of the day, but considerable time is given to drawing and theoretical instruction. By an ingenious arrangement a first-year student is put between a second and third year student that he may profit by their experience. Apprenticeship is made less of a tax on the city from the fact that the products of the classes are sold. The Boulle School trains skilled artisans and mechanics in wood and metal. The furniture construction is justly noted. The products are artistic as design is especially emphasized. The course is five years in length, primary academic instruction, trade work, technical art and a scientific course being included in its curriculum. Schools of printing and publishing, applied physics and chemistry, industrial art and industrial drawing are also supported by the municipality of Paris.

There are six municipal trade schools for girls in Paris. The instruction includes art, academic work and the chosen trade, and the courses are either three or four years in length. The trades taught are similar to those in Belgian trade schools for girls. The aim is to educaté for a trade, to develop the intelligence of the workers, and to teach them to be self-reliant and resourceful. The French schools execute practical order work in their departments, and every trade school in Paris has its clientèle. The model for these municipal schools is the private school begun in 1864 by Elisa Lemonnier. There are two of the Lemonnier schools in Paris at the present time. They offer courses of four or five years' in length.

The training for girls in the practical schools of commerce and industry (mentioned above) is similar to that offered in the Paris municipal schools. Schools are also organized which offer both home-making and trade. These are well patronized as many women desire both subjects.

UNITED STATES.

The United States had not many examples of the all-day trade school until recent years, for her problems of national development had taken her full time. The beginnings were usually under private control — illustrations being the New York Trade School for Boys and the Manhattan Trade School for Girls. The subjects of instruction at the former are the various building trades such as carpentry, bricklaying, sheet metal and cornice work, electrical work, house and fresco painting, plumbing, steam and hot water fitting, sign painting, plastering, blacksmithing and printing. It was founded in 1881 by the late Col. Richard T. Auchmuty, who originated the system of instruction. It includes the theoretical as well as the practical branches of the trade. The courses are made as short as possible — usually about four months for the day classes, which provide trades for younger men. The night courses aim to give additional skill to those already in the trade. The students come from all over the United States, and several thousand have received the certificate and twice as many more have been enrolled. It is claimed that this school has greatly helped the building trades and also has raised the standard of intelligence and efficiency in the working class. The Baron de Hirsch Trade School, also in New York city, offers similar trade training.

The Williamson Free School of Mechanical Trades, near Philadelphia, is a different type of trade school. The course is three years in length and the school term extends throughout the year. The pupils are regularly indentured as apprentices and live at the school. Scholastic examinations are required for admission, and there is no charge for board, clothing or instruction. The trades taught are carpentering, bricklaying, including range, furnace and boiler setting, and the machine trade in all of its usual details, patternmaking, steam and electrical engineering and steam fitting. Each student takes but one of the trades named, and his instruction in mechanical and freehand drawing is in the direction of his particular trade. The academic work continues throughout the three years, and special attention is given to ethical training that the pupils may be good citizens as well as good mechanics. It can accommodate but one-fifth of those desiring admission. There are three notable trade schools in San Francisco. The Wilmerding School of Industrial Arts trains for the building trades, the Lux School offers girls home-making and wage-earning courses and the Lick School of Mechanic Arts gives the metal trades. All three schools are under the same principal though financially independent. There is no charge for tuition, use of tools, instruments or materials. The courses cover four years and the aim is to send intelligent citizens as well as well-instructed workmen into the trade. Graduate courses are also given. The schools are built on adjacent lots and the students can use the shops of either institution. They are free, and the latter school is open to both sexes. A competitive examination is held for entrance at the School of Mechanical Arts. A preliminary course of more than two years in general education and manual training is followed by the selection of some trade and apprenticeship in it. The school aims to solve a general problem of teaching various trades as an integral part of education, rather than to meet some special need of the community.

The Wentworth Institute in Boston trains for various skilled mechanical trades in both day and night classes. Like other schools of its type it was of great service in training men for war occupations during 1917 and 1918.

The Carnegie Technical Schools of Pittsburgh offer trade work on a large scale to both sexes as a part of a huge plan of technical instruction. The School for Apprentices and Journeymen gives classes for those already at work. The instruction is both theoretical and practical, with the object of turning out skilled mechanics. The Margaret Morrison School for Women offers training in home-making and also in wage-earning pursuits.

The Manhattan Trade School for Girls in New York city is a short-time all-day preparatory trade school. It trains for skilled trade work. It is a pioneer school in this class of education and was begun in 1902 under private control, passing into the public school system in 1910. The aim is to shorten the period of apprenticeship of those girls who leave the public schools to go to work, and to create in them an appreciation of the meaning and value of their trade and its relation to the work of the world. The school is open throughout the year, students may enter at any time, are on probation for a time, and each is advanced according to her ability, hence there is no definite length of course; experience has shown that it may be anywhere between six months and two years. The trades offered are: (1) Those which centre about the needle, such as dressmaking and millinery; (2) those that use foot-power and electric-power machines, including such machines as those for embroidery, hemstitching and buttonholes; (3) those that depend on the expert use of paste or glue. such as labeling, sample mounting, pocket-book and card-casemaking, library outfits, blank book covers, and novelty boxmaking. Practical academic work, as well as drawing and color, are also taught, but always with an eye single to their bearing on the needs of each trade. A certificate is given only after a girl has been tested in a position and has shown her proficiency and also a good spirit in the workroom. The tuition is free, and in especially deserving cases some financial aid may be given to pupils. The school has the cordial support of some of the foremost philanthropists. trade unionists, social workers and employers of labor of New York city. The Boston Trade School follows closely the plan of the Manhattan Trade School for Girls. It was begun in 1904 and taken over by the city in 1908. Similar trade schools for girls adapted to their communities are found in other cities, Worcester, Massachusetts and Milwaukee, Wisconsin, being especially notable.

Schools for specific trades are to be found all over the United States. The Brewers' Schools of New York, Chicago and Milwaukee; the Schools of Watchmaking and Repairing in Waltham, Mass., and at the Bradley Polytechnic in Peoria, Ill., and the Barbers' Schools in Nebraska and other States are instances. Shipbuilding, photography, linotype and many other trades are taught in this class of school.

Business enterprises have also opened trade schools. Many of the institutes for dressmaking, so numerous in the large cities, were organized by some firm to teach a special system of drafting patterns.

The Apprenticeship or Corporation School is also found, being represented by such instruction as is given their workmen by the school of Messrs. R. Hoe and Company, manufacturers of printing presses, and the Carriage Builders' National Association (both in New York city), the Ladies' Home Journal, Philadelphia, the General Electric Company, at West Lynn, Mass., and great railroads, such as the New York Central and the Atchison, Topeka and Santa Fé.

Night classes for teaching trades are to be found in connection with the work of social and religious bodies. The Saint George's Trade School of New York city belongs to this class. The Catholic Protectory, near New York city, is teaching numerous trades for both sexes as a part of its scheme of reformation, and similar work is done in other institutions of this character.

Trade or technical teaching in institutions with other educational aims is found frequently. The pressure to introduce this work has been so great that trade classes have been offered in a variety of places, some of them receiving State or Federal aid. Much of the instruction is of a supplementary character, to take the place of apprenticeship. The technical features are usually more prominent than the special shop practice. Pratt Institute, Brooklyn, offers classes which resemble those of the trade continuation schools. The fundamental aim of the institute is for «industrial and technical instruction,» but it has responded to the call for trade training and has opened night classes to fit boys for carpentering, machine work, plumbing and fresco painting. Trade classes for girls are also given. The technical classes are justly noted, but they do not aim to prepare apprentices for the trade. The Drexel and Spring Garden institutes in Philadelphia, the Mechanics Institute in Rochester, the Hebrew Technical institutes for both sexes and the Clara de Hirsch Home in New York city and the Christian associations are instances of institutions with other aims giving attention to trade instruction.

The great schools for the colored people and Indians have been foremost in inaugurating trade education as an adjunct to their academic or normal aims. The Hampton Normal and Agricultural Institute in Virginia, the Tuskegee Normal and Industrial Institute and the Agricultural and Mechanics College in Greensboro, N. C., are examples of these schools. They have developed for both sexes almost all of the leading trades. The work is given in the most practical manner, as the shops are for productive industries and not alone for theoretical instruction. Trade teaching in these schools has been placed on a high ground and the results have justified the wisdom of the methods chosen.

Continuation, co-operative and part-time classes are increasing in number, Massachusetts, New York, Wisconsin and Indiana have been foremost in enacting laws to further vocational education and have organized various forms of trade classes to help their working people. Other States are following rapidly. Department stores are using the continuation schools for training their sales-people and are also organizing part-time classes in their own buildings. In Massachusetts the trade schools in Beverly and Fitchburg have begun an interrelation with the industries in their towns and the school in part-time instruction. Prevocational work in the later grades of the school is rapidly increasing and serves to guide young workers into occupations suited to their ability, thus preparing them for entering trade or taking further training at a school.

The passing of the Federal bill for vocational education gave a great impetus to training boys and girls below college grade for trades and industries. The aim of the measure, stated tersely, is to promote training in agriculture, trades, industries and home economics, and also to train teachers for vocational positions. The Federal board is also authorized to make investigations and to send out reports. It supervises and controls the work it assists, and works in connection with the State boards — the Federal and State boards acting as an agent. During the European War (by special legislation) it prepared men for various branches of war work and is still giving training to disabled soldiers, sailors and marines.

Austria.

The Austrian government has developed an exceptionally logical system of trade instruction for both sexes. The legislation in regard to fostering handicrafts has been similar to that taking place in Germany and has had a great effect on the development of trade training. The schools of all grades are carefully classified and grouped. The elementary education for trade is given in schools for particular trades and in the industrial continuation schools.

Another group, known as the Central Industrial Educational Institutions, which are most of them in Vienna, have for their function the promotion of industrial education and to serve as models for other schools of the empire. Some of these schools offer both a lower and a higher trade education in connection with their other important lines of investigation.

The Schools for Particular Trades are very numerous. There were about 100 state schools and more than half that number of private or state subscribed schools in the report of 1899. Important examples of this class are the schools for lace work and hand and machine embroidery in Dornbirn and Laybach; for weaving in Reichenberg, Vienna, Schönberg and Warnsdorf; for wood, iron and stone work in Bergreichenstein, Bozen, Chrudim, Bruck aus der Mur and Laas; for earthenware and glass-work at Teplitz and Oberlentensdorf; for metal work in Klagenfurth, Swiatniki and Nixdorf and for other trades in Gablonz, Turnau and Karlstein.

The Industrial and Trade Continuation Schools are also extensively developed and are similar to the German ones of the same name. They have reached their highest development in Vienna. A great central school enrolls about 8,000 pupils. The school is open for 10 months, six days a week. The work is compulsory for four years for both sexes. A watch and clock making all-day school is in the same building.

Switzerland.

The Swiss are an industrious and practical people and their schools show the national characteristics. This country has the distinction of having provided the model for the first French trade school. As early as 1599 Saint Francis de Sales conducted a school which maintained an industrial section. The Duke de la Rochefoucauld, while traveling in Switzerland, heard of the school, and, at his own expense, founded a similar one in France, which later became a National School of Arts and Trades.

The Federal government has developed an excellent system of subsidizing and supervising trade schools. The continuation school is the favorite, and they are similar in character to those of Germany, though the special trade features are not so well developed. They are found in all of the cantons and are for both sexes.

The Industrial Art Schools are giving training to apprentices in the trade, as well as advanced instruction. The cantonal School of Industrial Arts at Geneva, devoted purely to the art industries, and the Trade and Industrial Art School in Bern, combining other industries with its art work, are examples. Certain classes in both of these schools are open to women.

The Trade Schools proper cover a wide field of occupations. Of those teaching a simple trade, the watchmaking schools are the most numerous. Woodworking, embroidery and weaving schools are also characteristic of Switzerland. Many of the schools teach several trades. The course is usually three years in length and includes such art and academic work as is felt to be necessary for the understanding of the trade. These schools have had for their models the German, Belgian and French institutions of a similar character. The art work is generally less notable, however. The cantons of Appenzell, Bern, Geneva, Neuchatel, Saint Gall, Soleure and Zürich have successful trade schools as well as apprentice shops.

Trade instruction for women is also well developed. Many of the trade schools include the housekeeping element as is the case in Germany, Belgium and France. The Trade and Housekeeping School (école professionnelle-ménagère) in Geneva offers a three-year course. The work produced resembles the French in precision of technique and beauty of execution, but has, perhaps, less artistic value. Of the trade schools proper a good example is the school for ladies' tailoring and lingerie making at Zürich. Pupils must be over 14 years of age and present certificates showing a good general education. Courses of three or four years are offered, which include practical work at the chosen trade, theoretical instruction concerning it, auxiliary academic subjects, drawing and drafting and at least six months' service in a salesroom connected with the school. The Bern Women's Handwork School (Frauenarbeitsschule) also gives trade training, but does not at present include art or academic work in its curriculum.

Schools for housekeepers and servants have been developed in Switzerland and give excellent courses of several months' duration. All of the ordinary work of housekeeping, cooking, baking, preserving, serving, cleaning, sewing, repairing, washing, ironing, gardening, sweeping and putting rooms in order is included in the course. An effort to lengthen the time of training is being made. Lenzburg, Bern and Boniswil have good schools of this class.

The Swiss trade school is felt to have a beneficial effect on the working man and woman as well as on the industries, and is favored by the labor unions. Although the schools have not created new industries, they have been the means of developing many. The schools of wood-carving have done much to improve this trade, and machine embroidery has been, through the schools, brought prominently forward. The products of this industry are largely exported to the United States.

England.

The trade school proper was not developed to as great an extent in England as on the Continent. Although technical education has received attention, there have been until recently but few instances where the day schools aimed to take the place of actual apprenticeship. This was due largely to the Education Act of 1889, which forbade the practice of any trade, industry or employment in the schools. The education acts later took a more favorable attitude toward trade instruction, and government aid can now be given for fostering such schools. They are rapidly increasing.

Supplementary trade work is largely offered in the night continuation classes, which resemble those of Germany, and attract large numbers of students. There are 4,000 of these classes in London alone. Mr. Robert Blair, of the Mosely Educational Commission, says in his report on technical education in the United States: «We are in the main trying to do in one institution — the evening school — what Germans and Americans are in the main endeavoring to do in two.» The night classes are open to both sexes. Girls do not take much advantage of them, however, for the reason that nine or 10 hours of work during the day leave but little energy for resuming workshop practice.

Although the polytechnics have done much for the industries, it is only of late years that they have fostered real trade instruction in the day classes. Such instruction, however, has recently been increasing. A late report gives the number of day trade students in or near London as 5,800. These are provided for in 35 well-equipped workrooms (principally in the polytechnics) in which 200 courses are given bearing on 53 different trades. The evening classes are doing a fine work in training older workers for better positions. Day preparatory trade schools are being organized. Engineers of high rank are urging educational facilities for apprentices, workmen and experts equal to those offered on the Continent of Europe.

Trade training for girls has not been greatly encouraged by the working class. The germ of it has been in the excellent domestic economy schools. The Women's Industrial Council of London is doing much to foster trade schools for girls as a part of education. The London County Council has opened an All-Day Trade School of the preapprenticeship type. It began under private control but was taken over by the city in 1907. A girl can enter at 14 and remain two years. A day continuation school has also been opened for girls at work. The Borough Polytechnic in London opened in 1904 Day Trade Waistcoat-Making School for Girls, and other polytechnics have followed the example. General education, art and domestic science are included in the one-year course. The council is urging that similar day courses be offered at each technical institute in London, in order to train workers for all good trades employing women.

Italy.

Education for industrial pursuits began seriously in Italy after the national union. In 1898 vigorous reforms took place in the schools which raised the standard of teaching and reorganized the courses of study. The schools were founded chiefly by individuals. They differ widely in type, in object and in program. Many of the schools receive subsidies from the state as well as from the provincial or communal authorities, or from chambers of commerce, or from the savings banks. The government exercises a certain class of supervision over those schools receiving subsidies. Although there is no co-ordination between the schools there is a response to local needs. As in other countries, there are several grades of schools, The schools of arts and trades (scuole d'arti e mestieri) train the workmen. These institutions are very numerous in the cities and small towns, and are unevenly distributed through Italy. Piedmont, Lombardy, Campagna and Tuscany have the greater number. The instruction in many of them deals more with the technical features than with the academic and theoretical. As in other continental countries there are two classes of schools for apprentices: The day school to train workmen for trade, and the night or Sunday courses to improve workmen engaged in the industries. Everywhere there is the emphasis on the artistic side of industry. The Casanova Institute of Arts and Trades in Naples and the Municipal School of Arts and Trades in Genoa are illustrations of the day trade schools for boys.

Trade education for girls (scuole professionale) has received serious attention. The schools are largely attended. The parent institution is in Rome. It still remains a model for other schools. The girls enter at 12 years of age, on completing their elementary education and continue to attend the classes for three, four or even six years. The compulsory subjects are drawing and cooking. Optional subjects are languages, needlework in all branches, laundry work, lace and artificial flowermaking, hair-dressing, bookkeeping and arithmetic. There is also a nurses' training school. Similar schools are to be found in Florence, Milan, Venice, Turin, Parma, Bologna, Palermo and in some of the smaller towns.

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Mary Schenck Woolman,
Specialist in Vocational Education; Formerly Professor of Domestic Art, Teachers College, Columbia University, and Director of the Manhattan Trade School for Girls.

TRADE UNIONS, as defined by the Federal statutes, are associations of working people for the several purposes of aiding members toward greater efficiency, promoting their general intelligence, raising of funds for the benefit of sick, disabled or unemployed members or the families of deceased members, and for the regulation of their wages and hours and conditions of labor, and the protection of their individual rights in the prosecution of their trades. The primary object was to assist members in contests with employers, and it was not for some time later that the unions introduced funeral benefits, homes for incapacited workers, schools for instruction, etc. See AMERICAN FEDERATION OF LABOR; GUILDS; UNIONISM.

TRADE UNIONS, General Federation of, a labor organization of Great Britain, aiming to unite all the British trade unions for mutual assistance and the advancement of the interests of labor. It admits any trade union to membership, but no branches or individuals. It was organized in 1899 at a special session of the British Trades Union Congress. The government is vested in a general council of representative delegates meeting annually, and in an executive «management committee» of 15, no two to be of the same trade. District committees may also be organized. Any union dissatisfied with ruling of the management committee may appeal to the council, and from the council to the vote of the general membership. The federation deals solely with industrial questions, particularly with the conduct of strikes, and aims to preserve industrial peace. All unions joining the federation pay an entrance fee of one penny (two cents) per member and regular dues are paid on two different scales, the higher scale, sixpence (12 cents) per quarter per member, the lower scale, threepence (6 cents) per quarter per member; all payments are calculated on 90 per cent of the membership. In case of a strike approved by the general council or the management committee, unions that have belonged to the federation 12 months are entitled to a strike benefit of five shillings ($1.25) per week per member on the higher scale, and half that amount on the lower scale. Several large and representative unions have joined the federation; among them are the Amalgamated Society of Engineers, the Boot and Shoe Operatives, the Cotton Spinners, the Shipwrights, the Tailors and the Gasworkers and General Laborers; the membership approximates 1,000,000. See UNIONISM.

TRADE WINDS, one of those perpetual or constant winds which occur in all open seas on both sides of the equator, and to the distance of about 30° north and south of it. On the north of the equator their direction is from the northeast (varying at times a point or two of the compass either way); on the south of the equator they proceed from the southeast. In some places the trade winds become periodical, blowing one-half of the year in one direction and the other half in the opposite direction. They receive their name because their known regularity is an assistance to trading vessels which often lay their courses so as to receive as much assistance as possible from favorable breezes. See also CURRENTS, OCEAN; METEOROLOGY.

TRADING STAMPS, printed slips given by some merchants as an inducement to the trading public. They are usually gummed so that they may be pasted in a book which is furnished and which when filled has a value in premiums offered. These stamps are used extensively and are said to be of considerable value in working up trade. They have been the cause of lawsuits brought against the issuing firms under the laws forbidding lotteries.

TRADITION, the body of oral information, opinion, inexact records, statements and evidence of things long past communicated from older generations to the present. That evidence of ancient things which is not committed to writing and vouched for by competent authority. As applied to profane history it signifies knowledge of the past handed down by word of mouth from generation to generation. In this sense the line between tradition and myth is often hard to distinguish, one merging into the other. Historical tradition, however, has usually, if not invariablv. a substantial foundation and both tradition and myth are of the highest value in tracing human experience and progress both in the historic and prehistoric periods — for it should be unnecessary to state that the so-called historic period is not a uniform era, but varies with different races of mankind, according to the age at which they come within the range of historic observation.

Tradition in the religious sense holds a place not less important than in its profane meaning. It is a chief ground of doctrinal division in Christianity and also in Mohammedanism, between Roman Catholics and Protestants in the former faith and between Sunnites and Shiites in the latter. A similar division existed among the Jews of the later Scriptural period. In the Roman Catholic view the term tradition is applied to the doctrines believed to have been communicated by Christ to his Apostles and handed down by them orally to their successors. The writings of the Fathers are regarded as witnessing these traditions. The Council of Trent teaches that the truth of Christ is contained partly in the sacred writings and partly in unwritten tradition received by the Apostles from Christ, or from the Holy Ghost, and entrusted by them to the Church, and that Scripture and apostolic tradition are alike to be reverenced. See CATHOLIC CHURCH; JEWISH SECTS; MOHAMMEDANISM; PROTESTANTISM; SHIITES; SUNNITES.

TRADUCIANS (from *traduco,* transmit), a name which the Pelagians anciently gave to the Catholics because of their teaching that original sin was transmitted from father to children. More commonly the term is applied to the theory that souls are transmitted to children by the parents, instead of being created by God. Saint Augustine appears to have inclined to this belief, without committing himself to it.

TRAFALGAR, trăf-ăl-găr', or tră-făl'gar, a cape on the southwest coast of Spain, at the northwest entrance of the Strait of Gibraltar. It is low and sandy and terminates in two headlands, on the east of which is a martello tower. The famous naval battle in which Nelson lost his life, after defeating the combined French and Spanish fleets under the command of Villeneuve and Gravina, was fought off this cape 21 Oct. 1805. Consult Corbett, Sir J. S., 'The Campaign of Trafalgar' (London 1918).

TRAGACANTH, GUM TRAGACANTH, GUM TRAGIC, a gummy exudation from the stem of various species of *Astragalus*, natives of the mountainous regions of western Asia. It comes on the market as irregular leaves or ribbon-like pieces, of a white or brownish-white color and somewhat translucent. It swells up in water; does not readily dissolve but forms a gelatinous mass which is sometimes utilized as a mucilage. Used in pharmacy to give consistency to lozenge or pill mass. It is also used to stiffen calicoes and other fabrics.

TRAGEDY, a serious drama or poem, representing an important event or a series of events in the life of some person or persons, in which the diction is elevated and the catastrophe melancholy. Tragedy originated among the Greeks in the worship of the god Dionysus or Bacchus. See DRAMA.

TRAGOPAN, a pheasant of the genus *Ceriornis*, closely allied to the common fowl. *C. satyra*, a common species, is a native of the Himalayas where it inhabits the forests at 8,000 to 11,000 feet elevation. The plumage is spotted, exceedingly brilliant and variegated in colors and two fleshy protuberances hang from behind the eyes. When the bird is excited it can erect these protuberances till they look like a pair of horns. A large wattle hangs at either side of the lower mandible. Unlike most pheasants they build their nests in trees.

TRAILL, trāl, **Catherine Parr Strickland,** Canadian writer, sister of Agnes Strickland (q.v.): b. London, 9 Jan. 1802; d. Lakefield, Ontario, 29 Aug. 1899. She was married in 1832 to Capt. Thomas Traill with whom she removed to Canada in 1833 and made her home for the rest of her life at Lakefield, Ontario. Among her works are 'The Backwoods of Canada' (1835); 'Canadian Crusoes' (1852); 'Ramblings in the Canadian Forests' (1854); 'Afar in the Forest' (1869); 'Studies of Plant Life' (1884); 'Pearls and Pebbles' (1895).

TRAILL, Henry Duff, English journalist and man of letters: b. Blackheath, Kent, 14 Aug. 1842; d. London, 21 Feb. 1900. He was graduated at Saint John's, Oxford, 1864, called to the bar in 1868, but soon took to literature. He was connected with the *Pall Mall Gazette* (1873–80), the *Saint James' Gazette* (1880–82), *Telegraph* (1882–96) and the *Saturday Review* (1883–94). From 1889 to 1891 he was editor of the *Observer*, from 1898 to 1900 of *Literature*. Among his publications are 'Lives' of Strafford (a very original work with a new view) (1889); William III (1888); Sterne (1882); Coleridge (1884) and others; also 'Central Government' (1881); 'Recaptured Rhymes' (1882); 'The New Lucian' (1884; revised and enlarged 1900), his best work; 'Saturday Songs' (1890), satirical verse; 'From Cairo to the Soudan Frontier' (1896) and 'The New Fiction and Other Essays on Literary Subjects' (1897).

TRAIN, Elizabeth Phipps, American novelist and translator: b. Dorchester, Mass., 1 Sept. 1856. She was educated at Wells College, Aurora, N. Y., and her first literary work consisted entirely of translations from the French. They include 'The Apostate' (1889); 'Recollections of the Court of the Tuileries' (1891), etc. Her first original publication was 'Dr. Lamar' (1891) and she has since written 'Autobiography of a Professional Beauty' (1895); 'A Social Highwayman' (1895); 'Queen of Hearts' (1897) and other works.

TRAIN, George Francis, American financier and eccentric author: b. Boston, 24 March 1829; d. New York, 18 Jan. 1904. In 1850 he was put in charge of the Liverpool branch of an American business house and three years later was admitted to partnership. Another branch was established in Melbourne, Australia, in 1853, under his supervision, and during the three years of his stay there he introduced a sailing-ship service between Boston and Australia. In 1858 he interested English capital in the building of the Atlantic and Great Western Railway and afterward undertook street-railway enterprises in England and other European countries, but his plans, through opposition and otherwise, were frustrated. His next railroad enterprise was the building of the Union Pacific Railway, ground for which was broken at Omaha 2 Dec. 1863 and the connection that linked the eastern and western extremities completed 10 May 1869. He made a tour of the world in 80 days, arriving in Marseilles, France, 20 Oct. 1870, where he organized the Commune, was arrested and imprisoned for 13 days at Lyons. In 1872 he became an independent candidate for President of the United States. He was a man of eccentric habits and extravagant speech and in November 1872 was arrested on the charge of having published obscene literature. The passages objected to were wholly quotations from the Bible. Mr. Train was discharged from custody after having been adjudged insane by legal decision. His later years were spent in New York, where he adopted the habit of speaking only to children. He called himself "Citizen of the World," and while his title to property valued at $30,000,000 at Omaha, Neb., remained in litigation he affected a simple style of living and spent his last years at a cheap hotel, where he died. Among his publications are 'An American Merchant in Europe, Asia and Australia' (1851); 'Young America Abroad' (1857); 'Young America in Wall Street' (1858); 'Young America on Slavery' (1860); 'Championship of Women' (1868) and 'My Life in Many States and in Foreign Lands.'

TRAIN BANDS, a body of citizens partaking of the nature of both militia and volunteers, instituted by James I and dissolved by Charles II. The term was afterward applied to the London militia, from which the third regiment of the line originated and in which the renowned John Gilpin was a captain.

TRAINED NURSE. See NURSE, TRAINED.

TRAINED TEACHERS. See EDUCATION, ELEMENTARY.

TRAINING, Athletic. See PHYSICAL TRAINING.

TRAINING SCHOOL FOR TEACHERS. See TEACHERS, PROFESSIONAL TRAINING OF.

TRAINING SCHOOLS, Nautical. See NAUTICAL TRAINING SCHOOLS.

TRAJAN, trā'jan (MARCUS ULPIUS TRAJANUS), Roman emperor: b. Italica (near Seville), in the Spanish province of Bætica, 53

A.D.; d. Selinus, Cilicia, 117. He was the son of Trajanus, a Roman commander under Vespasian. He accompanied his father in a campaign against the Parthians and also served on the Rhine with such ability that when Nerva came to the throne he adopted the young soldier and raised him to the rank of Cæsar (97). Nerva dying a few months after, he succeeded to the throne (98). He was at that time in Germany, where he remained for more than a year, to settle a peace with the German tribes, and in 99 set out with a numerous escort to Rome. After largess to the soldiers and people he took successful measures for supplying the capital with corn. He punished and banished informers, reduced the taxes and filled the most important posts with men of talent and integrity. He moreover founded libraries, and under his patronage the studies were revived which had suffered from the persecution of Domitian. By the unanimous voice of the Senate he was awarded the title «Optimus.» In 101 he set out on an expedition against Decebalus, king of the Dacians, who had forced Domitian to purchase peace by an annual payment of money, and after two years defeated the Dacians and returned to Rome to enjoy the honors of a triumph with the name of Dacicus (103). In this year Pliny was made governor of Pontus and Bithynia, which circumstance gave rise to a series of letters between him and Trajan still extant. Among these are the epistles respecting the Christians, whom he directs Pliny not to search for, but only to punish if brought before him. In 104 Decebalus renewed the war with the Romans in pursuing which Trajan constructed a bridge over the Danube, below the modern Orsova, which was one of the greatest works of antiquity (105). He then marched into Dacia, reduced the capital of Decebalus and turned Dacia into a Roman province. It was in commemoration of his wars in Dacia that he erected the sculptured column which still bears his name. In 114 he dedicated the Forum that he had built in Rome and set out on a new warlike expedition against Chosroes, the Parthian. The result of this war was the reduction of Armenia to a Roman province. His war with the Parthians was completed in two campaigns, after which he sailed down the Tigris and entered the Persian Gulf. During his absence the Parthians revolted. After giving a king to the Parthians he laid siege to Atra, the capital of an Arabian tribe, but was obliged to withdraw to Syria. In the following year (117) he proposed returning into Mesopotamia, but was attacked by a disorder, which induced him to repair to Italy, leaving the army under the command of Hadrian. He had proceeded no farther than Selinus, in Cilicia, when he died, after having adopted Hadrian for his successor. His good qualities as a ruler were such that, at the distance of 250 years from his death, the senators, in their acclamations on the accession of a new emperor, were accustomed to wish that he might be more fortunate than Augustus and better than Trajan.

TRAJAN'S COLUMN. See ROME; TRAJAN.

TRAJAN'S WALL, Rumania, a fortified line in the Dobrudja extending east from the Danube to Kustendji on the Black Sea, a distance of 37 miles. It is a double, in some places, a triple, earthwork on the south side of a natural fosse consisting of a narrow marshy valley. Another wall of the same name, built by a Roman legion, 105–155 A.D., extends from the Pruth east to the Black Sea.

TRAMP. See MENDICANCY.

TRAMWAYS, Aerial. See CONVEYER; WIRE ROPE.